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FEBRUARY 1958

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NUCLEAR ISSUE

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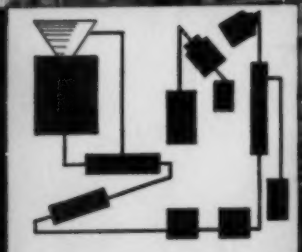

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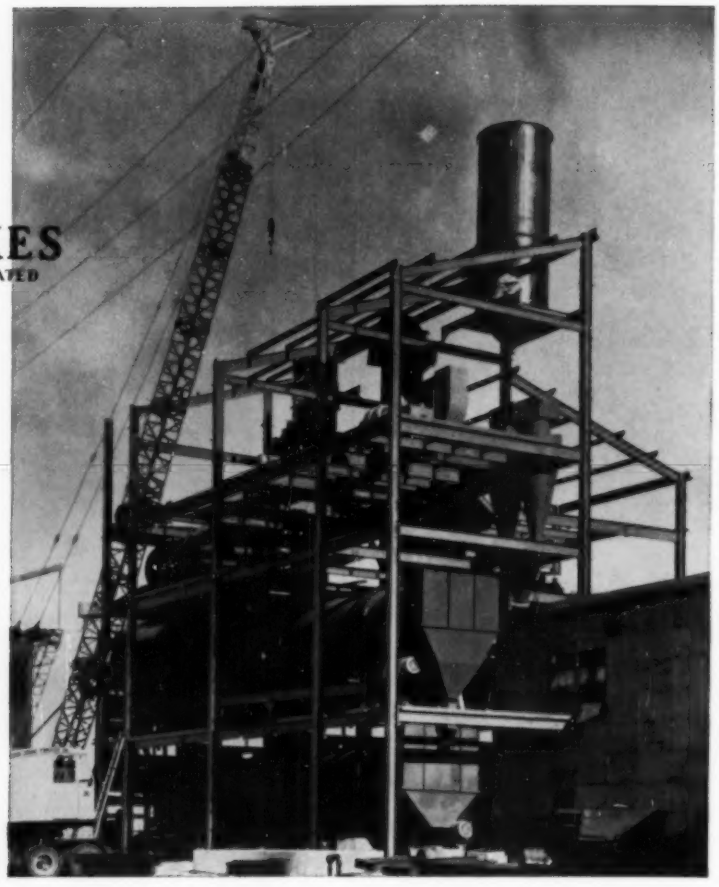

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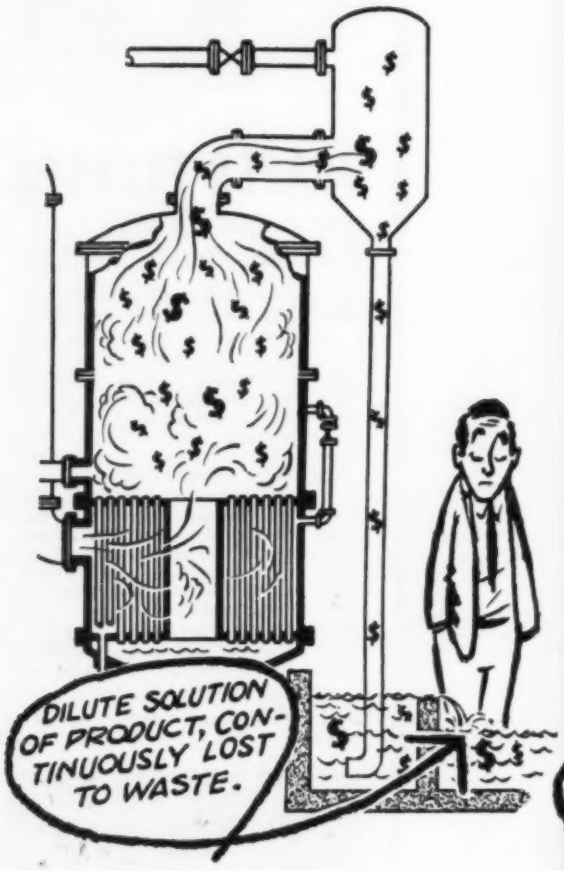

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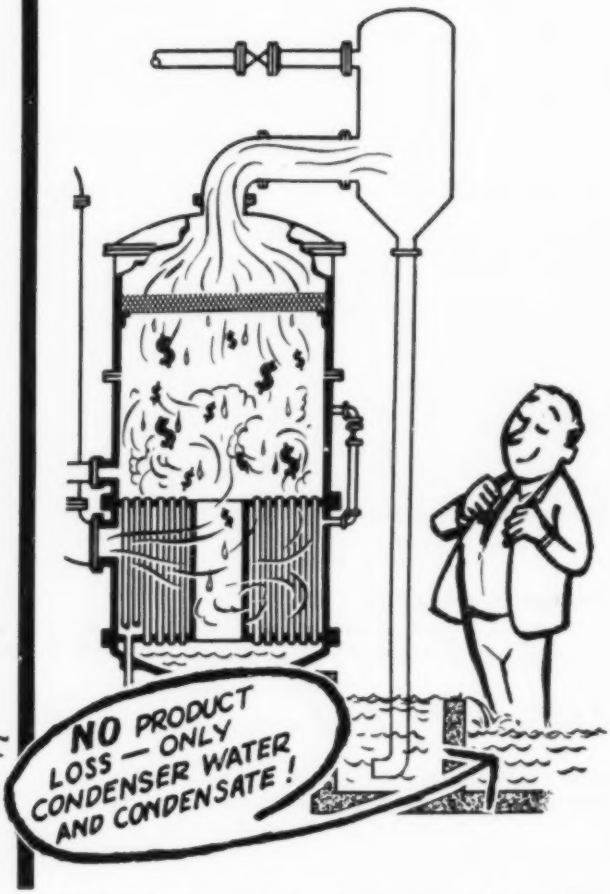

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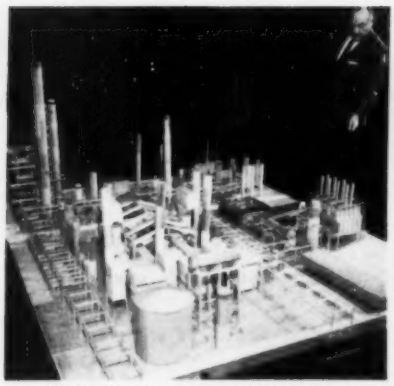

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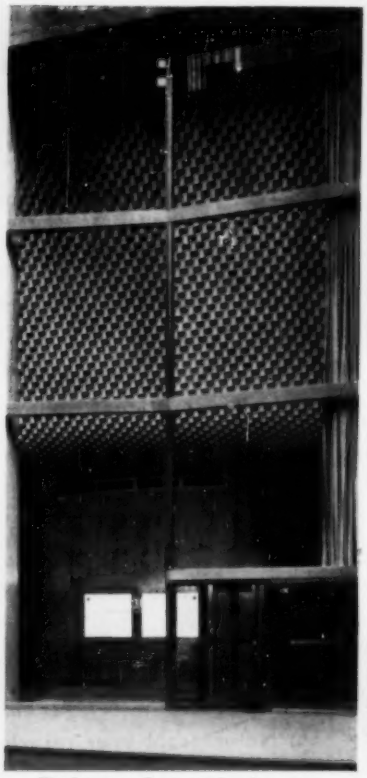

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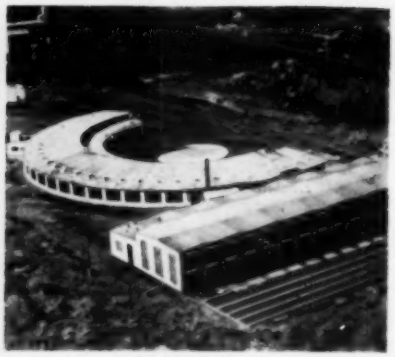

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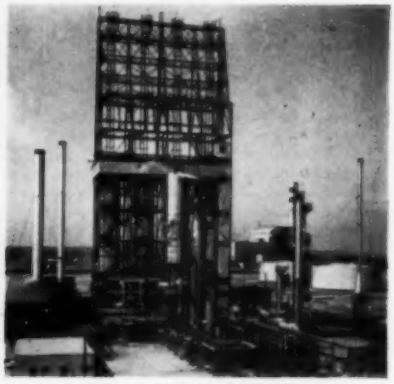

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CHALLENGES AHEAD:

NUCLEAR POWER DEVELOPMENT

W. Kenneth Davis *

Director, Reactor Development Atomic Energy Commission Chairman, Nuclear Engineering Division, A.I.Ch.E.

Significant as are the nuclear energy problems which chemical engineers have solved, it seems safe to say that even more imposing ones lie ahead waiting to be solved. The largest number of these seem to be related to the development of reactors for production of electric power, the civilian application most likely to have large economic significance in the near future.

Here are some of the more important problems inherent in the development of power reactors, with mention of their chemical engineering aspects:

There is a need to find acceptable and sufficiently cheap structural and fuel cladding materials for high temperature power reactors. The rate of chemical reaction between the coolant and the material is one determinant of suitability. Nuclear and radiation effects seriously limit the choices available and affect the basic phenomena.

It has been found desirable to use in nuclear reactors some exotic materials not previously needed in large quantities by industry. These materials (graphite, zirconium, beryllium, boron, hafnium, and others) have proved to be quite costly. Processes must be developed which will produce them cheaply, with the requisite degree of purity, and with the proper metallurgical and physical properties.

Fuel materials must be developed which can be fabricated cheaply and which will have a long useful life. Further work must be done on processes for recovering and purifying uranium and thorium, especially from lower grade ores. There is need to reduce still further the costs of isotopic enrichment. Ways must also be found to produce uranium or thorium fuel in such a form that it can be fabricated cheaply. For example, the step of converting enriched uranium hexafluoride to uranium dioxide is now a very expensive one, and without apparent reason.

Along with the costs of the fuel material, the costs of cladding materials (such as zirconium) and the costs of actually manufacturing fuel elements must be reduced. It may be possible to reduce fuel element fabrication costs by using remote continuous processes. Such methods will be necessary if we are to utilize plutonium, U-233, or partially decontaminated fuel materials.

A great deal has been said about the necessity for developing cheaper, smaller, and more flexible processes for recovering source and fissionable materials from highly irradiated high temperature power reactor fuel elements and for permanently and safely disposing of the wastes from such operations. These are most important areas which are receiving much attention now from chemists and chemical engineers.

Fluid fuel reactors such as the aqueous homogeneous reactor or the liquid bismuth-uranium fueled reactor might be characterized as "chemical engineering" reactors. They seem to avoid the expensive and difficult problems of fuel element manufacture at the expense of even more severe materials problems, at the hazard of difficult and expensive maintenance, and without altering the chemical processing problems in any substantial way. However, if the problems of such reactors can be solved in ingenious ways they might turn out to be most successful. The solution is not clearly in sight at the moment. The intermediate solution of a homogeneous fuel element for a heterogeneous reactor deserves further work in any case.

The development of fabrication and processing techniques which will permit the utilization of plutonium as en-

(*Continued on page* 10)

* Condensed from remarks by Mr. Davis before a luncheon meeting of the A.I.Ch.E., Chicago, December 11, 1957.

ENGINEERING UNITY

E. R. Needles, 1958 President, EJC

What is ahead for 1958? The challenges and opportunities before us in the coming year are without precedent. Of continuing interest is our endeavor toward complete unity in E.J.C. on the part of all our major engineering organizations. I hope that we may see our greatest wishes realized during 1958. The possibilities of rather complete unity within E.J.C. do not appear out of reason.

We have the continuing job of supporting and furthering the best interests of Engineers Council for Professional Development, especially in the vital field of accreditation of engineering curricula. We will continue our endeavors toward bringing about a comprehensive survey of the engineering profession. In the light of international developments in recent months, the characteristics and purposes of this survey may be greatly clarified.

Of tremendous continuing importance is the work and position of our Engineering Manpower Commission. To me, the importance of this Commission is greater than ever before, and we must all agree that this work must not suffer in any way through lack of finances. If the engineer is ever to have a voice to be heard by his fellowman, this year of 1958 is clearly the time.

Our National Engineers Committee will surely have important things to do this next year. Possibly this Committee and our Engineering Manpower Commission can help to offset some of the political propaganda, research, and tests by radio, television and headlines, and hysteria brought on by demagogues, to which our people have been exposed ad nauseam in recent months.

Should not the many societies which make up E.J.C. be encouraged to express their views to the appropriate committees in E.J.C. relative to these questions of national import, so that the voice of the engineer can truly and clearly be heard in our land in the year 1958?

I believe there are some things on which we of the great engineering profession have both the right and the *obligation* to express our judgment and views during 1958. Who could speak better? Numerous plans are now being presented to produce revisions in our educational processes, all being slanted specifically toward the education of our future engineers and scientists. In the minds of many, the program of greatest excellence must be the one which costs the most money. The idea appears to be that if we increase the quantity of our engineers and scientists, the desired quality will follow automatically. Apparently our greatest engineers and scientists of the future are those who heretofore could not get past high school because of lack of scholarships. If

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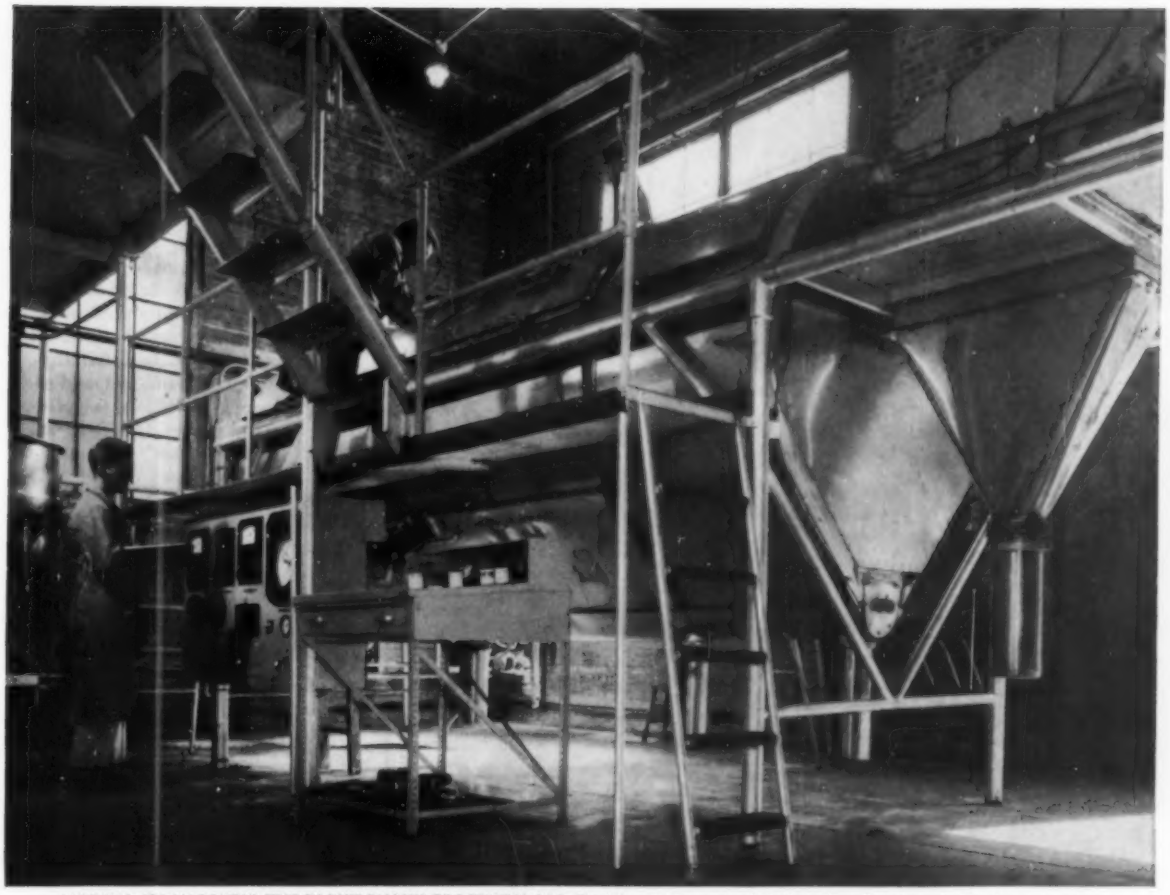

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Challenges Ahead: Nuclear Power

(*Continued from page* 8)

richment in reactor fuels is of great importance in the international aspects of the U. S. power reactor program. Natural uranium resources, moreover, can be extended by a factor of perhaps 2 to 4 if plutonium produced in reactors can be used as reactor fuel. This is a crucial problem for metallurgists, chemists, thermodynamicists, and engineers. A similar problem exists with respect to the use of U-233 as a reactor fuel.

An important area for chemical engineers is the exploration of the factors affecting the safety of reactors, a program of increasing size and importance at the present time. Many of the potential hazards arise because of the possibility of chemical reaction among fuels, claddings, coolants, structural materials, and steam or air. Studies of the chemistry, kinetics, thermodynamics, and engineering of each possibility is necessary in order to assess the hazard and control it.

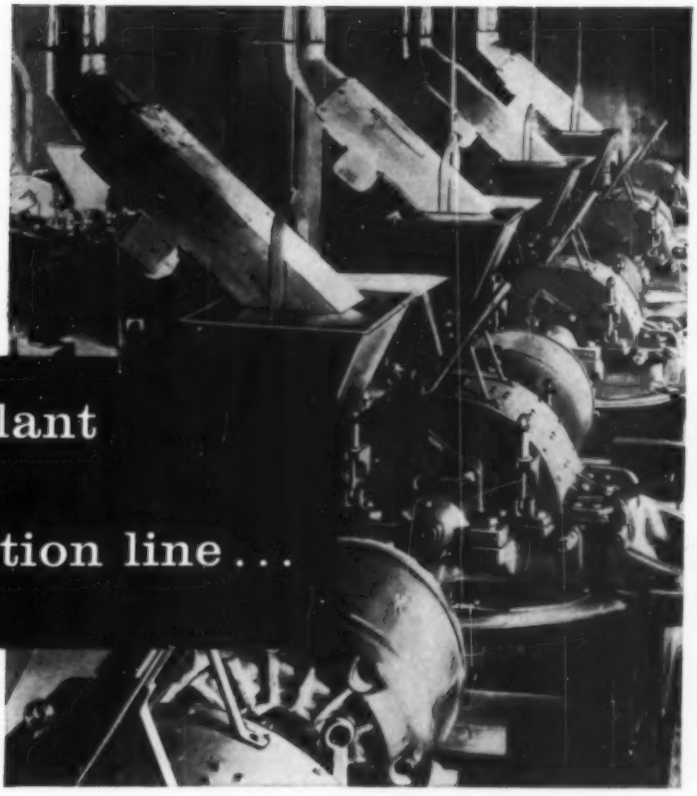
Studies of the fluid mechanics and heat transfer phenomena in the reactor under steady state and transient conditions are also most important to reactor design and safety analysis. In addition to effects on chemical and nuclear reactivity there are many complex questions of thermal stresses. The feedback and control characteristics of the reactor system as a whole is also fundamental to such studies.

In the case of a nuclear incident the phenomena of blast and shock are of basic importance. A great deal of research remains to be done on these phenomena and on the problem of containment and blast protection. Studies are needed on atmospheric diffusion, on the chemistry of airborne fission products, and on chemical methods to reduce the amount of fission products released and the potential hazard from them.

It seems likely that in time economic industrial uses will be found for fission product isotopes. In anticipation of this demand, processes need to be developed for recovery of these isotopes from chemical processing wastes.

The challenges for chemical engineering in the power reactor field alone are formidable indeed. Other applications of nuclear energy loom on the horizon. The development of each of these is likely to pose further problems which chemical engineers will be called on to solve.

(*More Noted & Quoted on page* 16)



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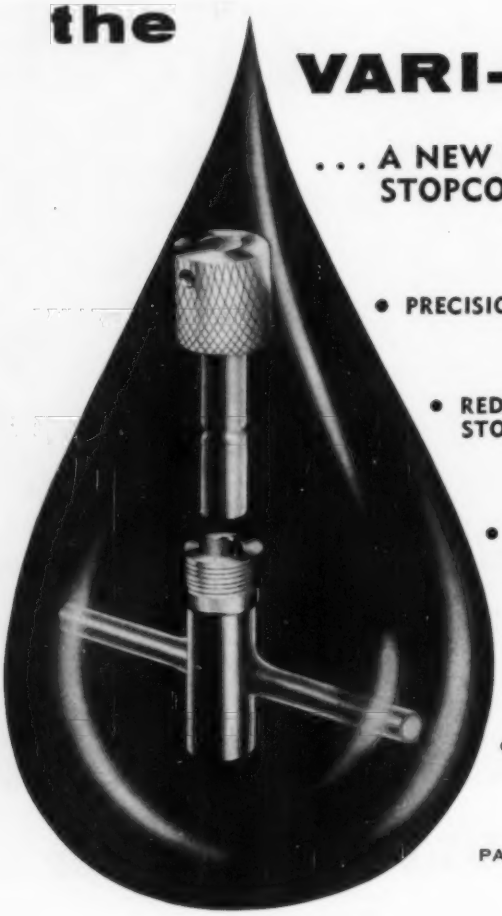
MANUFACTURERS OF PULVERIZING, AIR CONVEYING AND DUST COLLECTION EQUIPMENT

the VARI-FLO®

. . . A NEW STANDARD IN STOPCOCKS

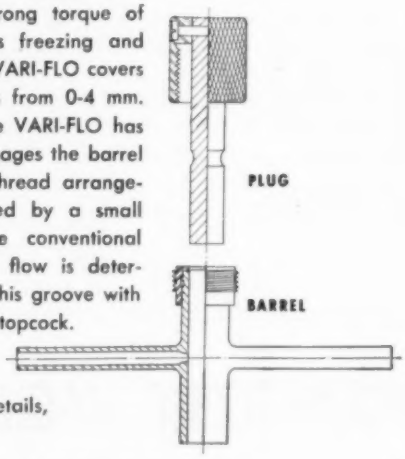


- PRECISION FLOW CONTROL
- REDUCES NUMBER OF STOPCOCK SIZES
- CONTROLS LIQUIDS AND GASES
- NO FREEZING
- ALL GLASS BODY

PATENT PENDING

The unique design of the new VARI-FLO stopcock offers many distinct advantages over conventional stopcocks. The plug turns on a micrometer-like screw thread which makes precision flow control possible. The all-glass body is inert to most liquids and gases. The strong torque of the screw action eliminates freezing and "stick-slip" operation. One VARI-FLO covers the range of stopcock sizes from 0-4 mm.

As illustrated at right, the VARI-FLO has a cylindrical plug which engages the barrel by means of an external thread arrangement. The plug is encircled by a small groove which replaces the conventional plug bore. The control of flow is determined by the alignment of this groove with the inlet and outlet of the stopcock.



For more complete details, write for Bulletin 101.

WILMAD GLASS CO., INC.
LANDISVILLE, N. J.

Noted and quoted

Challenges Ahead: EJC

(*Continued from page* 8)

some of the proposed plans go into effect, we may never have a future shortage of so-called engineers and scientists, but there may also be a serious question as to how well compensated our engineers and scientists of the future can become in the face of a glut of mediocrity. We engineers can well give thought to what we should say for the greater good of our nation—and then say it!

The situation in which we find ourselves is not the result of technological failure. It is rather the result of mistaken decisions in program emphasis and manpower administration during the past decade. To ascribe the Russian rocket and satellite lead to weakness in American technology is misleading and erroneous. There is no evidence to indicate that the "race" is temporarily lost for technological reasons.

There is no question but that any one of several engineering and scientific organizations could have won the race to get an earth satellite into the air if this had been considered of prime political significance, or if this were to have been used as the basic measure of our technological excellence. We have not lost our technological leadership or engineering productivity, but we must push everlastingly forward in our educational processes for engineers and scientists and the orderly and intelligent administration of their endeavors and services.

We recognize that educational reform can have absolutely no effect on our technological performance during the crucial next three years when our technical accomplishments must be truly in keeping with our great capabilities to restore the temporarily dimmed prestige of the U. S. The first step the country must take is to provide adequate administration and direction for the technological team of scientists and engineers which exists. There is no reason why the United States cannot have, at one and the same time, a continuing rise in the living standard and a defense capacity of ever-increasing strength.

Surely the year 1958 is a year of challenge and opportunity for Engineers Joint Council.

E. R. Needles

Mr. Needles is the newly-elected president of EJC. See People, page 202.

(*More Noted & Quoted on page* 16)

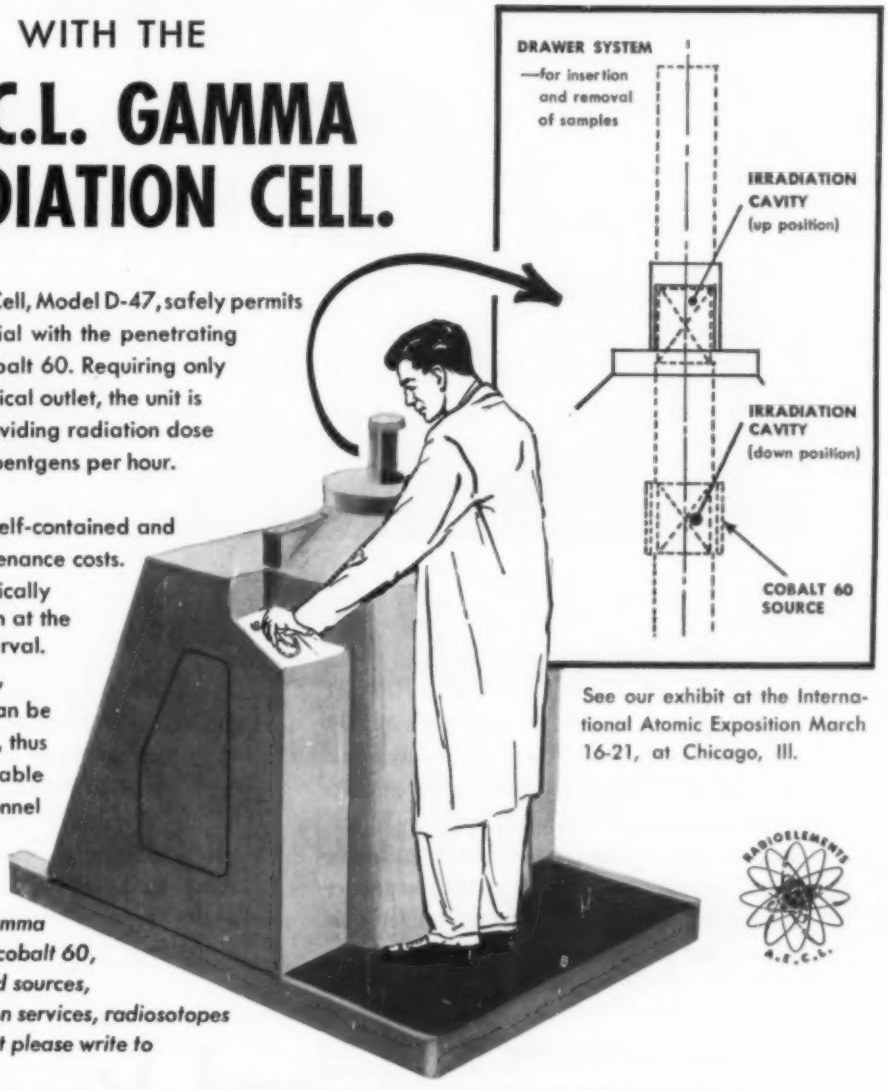
NOW - STUDY THE EFFECTS OF GAMMA IRRADIATION IN YOUR OWN LABORATORY

WITH THE

A.E.C.L. GAMMA IRRADIATION CELL.

The Gamma Irradiation Cell, Model D-47, safely permits the irradiation of material with the penetrating gamma radiation of Cobalt 60. Requiring only a connection to an electrical outlet, the unit is ready to go to work providing radiation dose rates up to 1,000,000 roentgens per hour.

The D-47 is completely self-contained and is virtually free of maintenance costs. A timing device automatically terminates the irradiation at the end of a preset time interval. With minimum instruction, a series of irradiations can be handled by a Technician, thus conserving the more valuable time of supervising personnel



See our exhibit at the International Atomic Exposition March 16-21, at Chicago, Ill.

For information on the Gamma Irradiation Cell, kilocurie cobalt 60, radiography machines and sources, neutron sources, irradiation services, radiosotopes and teletherapy equipment please write to

ATOMIC ENERGY OF CANADA LIMITED

COMMERCIAL PRODUCTS DIVISION

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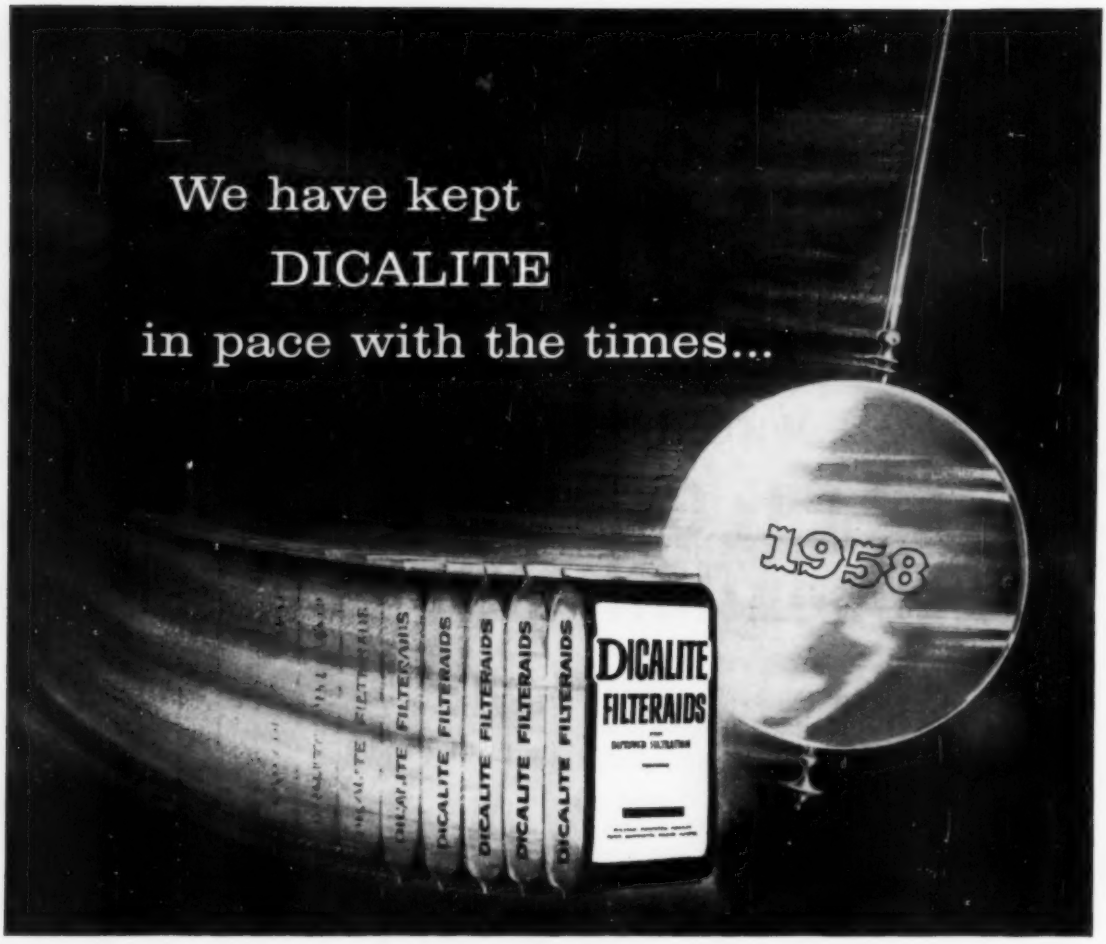

Even though the bag bears the same name as for many years past, the Dicalite Filteraid in the bag is not the same—it has been quietly and steadily improved. You can probably prove this yourself, simply by checking your own processing records of, say, ten years back; you will, we believe, find that under comparable conditions today's Dicalite is giving you greater throughput per pound of filteraid, longer filter cycles, and perhaps improved clarity.

This improved performance has been built into Dicalite Filteraids through the steady, day-in, day-out work of our laboratories and engineers. Nothing dramatic—a slight gain here, a small advance there, a little improvement at another stage—a multitude of small refinements whose cumulative total is substantial and impressive. These improvements are demonstrated daily in your own processing... the ultimate test which proves

There Are No Better

Diatomite Filteraids than those produced by . . .

Dependable GLC GREAT LAKES Dicalite® DIATOMACEOUS MATERIALS

DICALITE DEPARTMENT

GREAT LAKES CARBON CORPORATION • 612 SOUTH FLOWER STREET, LOS ANGELES 17, CALIF.

Major chemical producer meters flow of catalytic agents with Cleveland Speed Variator

A chemical research worker adjusts the manual control knob on the Cleveland Speed Variator to set the metering speed. Various types of regulating mechanisms can be mounted on the Variator to provide automatic adjustment by remote control.

IN the research department of a major chemical plant, catalytic agents are metered and their flow varied with precision accuracy. This control is exercised with a Cleveland Speed Variator.

A ¼-horsepower electric motor is connected to the Cleveland Speed Variator driving a pump through a 25-1 speed reducer. Being infinitely variable, the Variator gives stepless speeds over its full 9:1 range—from ⅓ to 3 times input speed. Pumping speed can be varied from 207 to 23 rpm. This provides the necessary speed range for metering the various types of catalytic agents.

Available in eighteen standard types and sizes, the Cleveland Speed Variator offers these major advantages: 1. An extremely compact unit; 2. Almost any input speed up to 1800 rpm—clockwise or counterclockwise; 3. Constant horsepower output over a 9:1 range, or constant output torque with a 6:1 range; 4. Infinitely variable over entire speed range; 5. Rapid response to speed change, precise adjustment, accurate maintenance of settings; 6. Long life and minimum maintenance; 7. Ample bearing support for overhung pulleys on either input or output shafts.

Write for Bulletin K-200 for detailed description of the Cleveland Speed Variator, with photographs, sectional drawings, rating tables and specifications.

THE CLEVELAND WORM AND GEAR COMPANY

Speed Variator Division, 3257 East 80th St., Cleveland 4, Ohio

Sales representatives in all major industrial markets. In Canada—Peacock Brothers Limited.

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Baird Atomic

Noted and quoted

Knowing Your CBR

Major General Wm. M. Creasy
Chief Chemical Officer, U. S. Army

The public should know much more about this [chemical, biological, and radiological] type of warfare.

An unfriendly nation gauging our ability to defend ourselves and the rest of the Free World will be well aware of our strength in the nuclear field and will govern its plans accordingly. It must be made aware also of our ability to defend ourselves in the toxicological field should it be tempted to resort to the use of such weapons.

We know that other nations are fully aware of the potentialities of gas and disease germs as a means of war. . . . We can safely assume that chemical and biological weapons figure prominently in the Soviet arsenal.

How well I have succeeded in my efforts [to disseminate as much information as possible], I cannot say. I do know that there is still a tendency for many people to bury their heads in the sand at mention of chemical and biological warfare. This is the type of thinking in which an aggressor would like us to indulge. If carried far enough, this attitude will leave us defenseless in a method of warfare which offers many advantages to an enemy. . . .

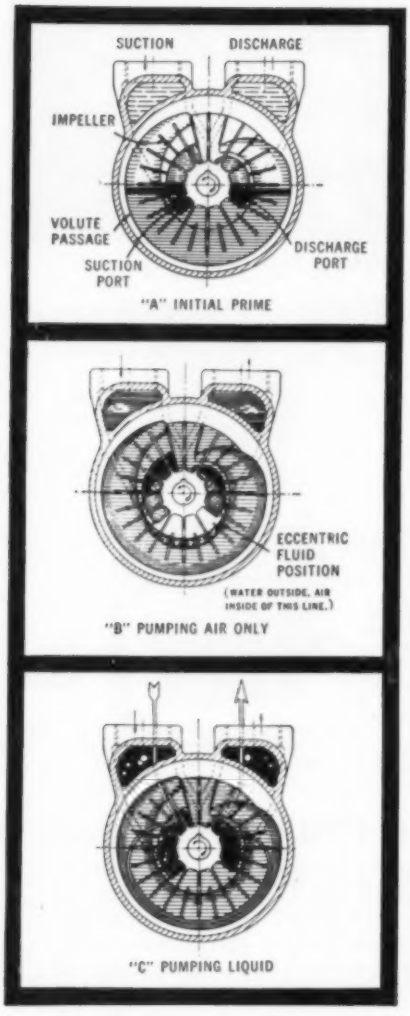
The development of means of defense against CBR weapons is an important phase of the work of the Army Chemical Corps. As a companion to defense, we are, of course, intimately concerned with the development of methods for direct use of CBR weapons should an enemy decide to use them first. . . .

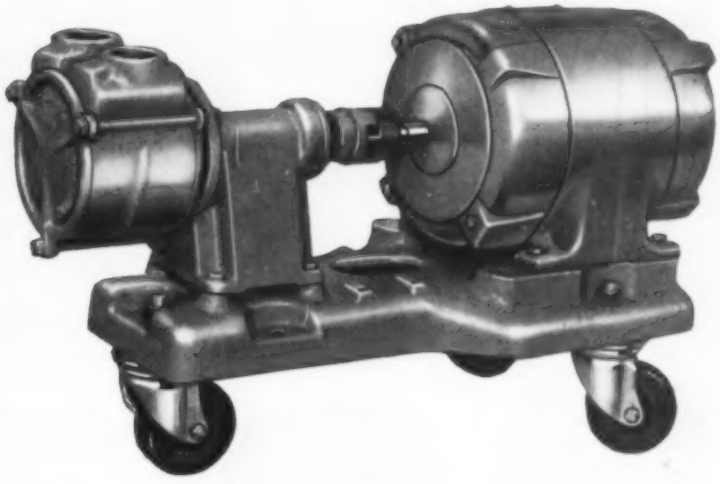
Recent [defense] developments include methods for detecting the presence of nerve gases in the air. We also have the means for detecting and identifying disease germs much more rapidly than heretofore. [We have] a material which can be used in masks and shelters to filter out air contaminated by chemical agents, germs, and radioactive dust. We recently announced the development of a new mask for troops [also for Civil Defense] which filters out the CBR agents. There are many other developments. . . . We are constantly working on the problem of immunization against disease germs that might be used in biological warfare attack. There is a great deal more to be done.

Condensed from Armed Forces Chem. J.; Jan.-Feb. '58

NOW there's a better pump for the toughest transfer service

Goulds new self-priming Liquid Ring Pump pumps liquid... pumps air... pumps liquid and air





Now you can get quick and continuous self-priming with a pump that handles any combination of air and liquid.

This unique new Goulds pump puts *centripetal* action to work to eliminate manual priming and air binding. Even with loops or leaks in your suction line its high air handling capacity keeps the liquid moving.

The pump's impeller and a volute casing achieve the self-priming. The impeller forces liquids along the volute, building up pressure as the liquid moves to the narrow end. This pressure sets up a liquid piston action between each set of blades, forcing liquids to the center of the pump. The liquid piston forces any air entrapped in the center up through the outlet.

The Goulds Fig. 2520 pump is available in all-iron construction, or in stainless steel for corrosive service. Offered as a mobile unit (as illustrated), pump-motor unit, or pump only for V-belt drive. With 1½ inch suction and discharge, the pump itself weighs 42 pounds. Capacities to 60 GPM, heads to 80 ft.

There's a complete description of the pump in Bulletin 725.6. Write for a copy or contact your Goulds representative.

GOULDS

PUMPS FOR INDUSTRY

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HOUSTON, 2314 Main Street
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PHILADELPHIA, 2099 North 63rd Street
PITTSBURGH, Room 512, Bessemer Bldg., 104—6th Street
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Recess retains gasket in coupler and assures proper placement
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You can *speed work—prevent leakage—save wear on equipment* by using an EVER-TITE in every operation that calls for couplings. Ever-Tite always gives you tight, quick connections because Ever-Tite has positive gasket compression that is dependable under *all* conditions. Get Ever-Tites—get a *quick, safe, tight* couple every time. Ever-Tites are available in:

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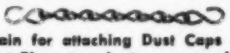

Chain for attaching Dust Caps on Dust Plugs to adapters or couplers

EVER-TITE COUPLING CO. INC., 254 WEST 54TH STREET, NEW YORK 19, N. Y.

NEWS PLUS INTERPRETATION

SCOPE

New Plant Costs Down 15% . . . Equipment Manufacturers Customize

An impelling reason for building now was cited at the January meeting of New York's Chemical Equipment Sales Engineers' Association (CESEA). Costs of plants now under construction were reported as being up to 15 per cent lower than the most recent plateau. Savings were said to arise principally from improved availability of skilled labor at the plant sites during the specific periods needed for most efficient erection.

Equipment manufacturers' costs, on the other hand, are either the same or higher than a few months ago, reported representatives at this meeting. The fact that today's buyer of process plant stands to get better value for his firm's money arises from the seller's ability to devote more engineering staff time to custom designing of the equipment for the intended application. Such efforts are being well received, according to the group.

CESEA is an organization of sales engineers who are New York representatives for major equipment manufacturers.

EXHIBIT PROCESS EQUIPMENT IN ENGLAND THIS SUMMER

Great Britain has announced its first "Chemical and Petroleum Engineering Exhibition" to be held at Olympia (London) June 18-28, 1958. The exhibition is being sponsored by the British Chemical Plant Manufacturers Association and the Council of British Manufacturers of Petroleum Equipment.

Forming part of the 1958 program of the European Federation of Chemical Engineering, the exhibition will parallel a symposium on The Organization of Chemical Engineering Projects which will be staged by the Institution of Chemical Engineers.

250 exhibitor manufacturers are said to have booked stands, occupying the whole of Olympia's two largest halls and galleries.

Taking place a few days following the Brussels meeting and the ACHEMA exhibition and meeting at Frankfurt, these events will enable the visitor to enjoy a vacation or make plant visits for the ten day period.

AtomFair Total

AtomFair, forthcoming (March) Chicago nuclear exhibition, has a total of more than 93 exhibitors planning to have displays up to the time of going to press. (See page 190.)

Liquefied Natural Gas?

A British firm has been formed to transport refrigeration-liquefied methane from natural gas producing areas to England. Firm is the Constock Liquid Methane Corporation. If successful, this technique may make lower cost gas available to countries in which it is not now available. No information is yet released regarding storage, etc.

NSPE Comes Out for Function-recognition

The National Society of Professional Engineers has issued a policy statement on engineering titles as a proposed guide to industry. In brief, the policy advocates that "engineering" titles should be used in a position description only when the individual meets a minimum standard of qualification such as registration under a state engineering registration law, graduation from an accredited engineering curriculum, or coverage by an official ruling under Taft-Hartley or Fair Labor Standards relative to an engineering position and 'professional' status under one of these two laws. Ideally, NSPE policy calls for registration. However, as a practical first step to eliminate the more serious abuses (such as granting engineering titles to subprofessionals) the policy accepts these other minimum standards.

Super Organization for Metals

A new Ti-Zi "giant" has come into being—Mallory-Sharon Metals Corp. Owned equally by National Distillers, P. R. Mallory, and Sharon Steel, the new firm takes over the production and fabrication facilities of these firms, plus those of Reactive Metals and Mallory-Sharon Titanium. Assets total $55 million.

Missile Partnerships

Army's announcement that a new fuel was used to power the first stage engine of the Jupiter "C" satellite missile focuses attention on the fuel as being still in a dynamic state of development. Described as Hydyne, a hydrazine-based compound developed by Rocketdyne, the new fuel is said to have increased thrust and missile range by 12 per cent over the conventional Jupiter engine powered by alcohol. The wave of rocket engine-chemical firm partnerships reported elsewhere in this issue is apparently arising from a growing recognition that rocket fuel and engine developments must be closely synchronized.

EJC Sets TV Policy

Engineers Joint Council (EJC) has set a policy that will permit lending its name or collaboration to production of TV or radio programs. This decision paves the way for EJC's public relations director or staff to come in for short-notice "spot" participation.

SCOPE

Status of inventor at low ebb with government?

Survey reveals . . . Inventors prefer industry to government

Plus: latest on Spevak case

The nation's inventors prefer to work in private industry rather than with the government. This was one of the conclusions reached from a survey conducted by a group at Georgetown University, and comes from a report released recently by the National Inventors Council, an organization which concluded that more adequate rewards for inventions aiding national defense should be paid by the government.

Among the reasons for preferring industry offered by the inventors are: greater financial rewards, less red tape, and more interested and helpful people to work with.

Red tape was the most often cited reason for inventors' breaking off with the government. A complaint affecting government relations was that inventors have difficulty knowing what the various government agencies need in the way of new inventions.

The survey was conducted by Georgetown's Patent, Trademark and Copyright Foundation.

SPEVAK CASE STILL ACTIVE

Members of the profession awaiting the release of further information on the manufacture of heavy water are probably aware that the holdup is the result of a court action taken by an inventor (Jerome S. Spevak) who has sought injunctions to give him time for filing foreign patent applications. Here is a brief history of the subsequent developments, which reveal how this case has become one of broad interest as affecting the rights of all engineers and scientists who may invent in the atomic field.

The inventor (Spevak) believed he discovered a process which was vital to the nuclear developments of the U.S. He filed an application for patent rights, but immediately the AEC placed a top secret classification on his discovery and application. Under the authority of the 1954 Atomic Energy Act, the AEC was empowered and required, upon declassification of any such information, to publish the information relative to the process.

The inventor, having filed prior to the discovery's being classified, was protected in the U.S. However, publication by the AEC would prohibit him from filing for foreign patents as public disclosure prior to filing invalidates such patent applications in some countries.

To obtain relief, the inventor secured an injunction from the U.S. District Court against the AEC. After this was granted, the inventor appealed to the U.S. Court of Appeals. This court has ruled that the inventor is suing the U.S. Government without its consent and also that the Court has no jurisdiction in this subject. This action would appear to deny relief to inventors on any discoveries or inventions which have been taken over by the U.S. Government under the Secrecy Act and subsequently declassified in the public interest.

To forestall disclosure until settlement of the question, the inventor next obtained an injunction from the Supreme Court to give him time for the filing of a writ of *certiorari* asking the Supreme Court to review the case and determine whether in actuality the Federal Courts do have jurisdiction. If the Supreme Court should rule against this petition, the picture would be clarified to the extent that a change in the legislative statutes would be indicated, and those organizations and societies interested in this problem would be in a position to initiate the necessary steps.

EJC ENTERS CASE

EJC's Board of Directors, after considering this case at its November 15, 1958 session, appointed a special committee to study the situation for the purpose of determining whether EJC should file with the Supreme Court a brief *amicus curiae* (friend in court) with regard to inventor Spevak's petition. Subsequently, such a brief has been filed by EJC's attorneys, which contains the concluding words: "Consequently, under the ruling of the U.S. Court of Appeals . . . the Atomic Energy Act prohibits an inventor from enjoining the publication of his invention without just compensation, and the courts have no jurisdiction to entertain the action, which of course is in violation of the U.S. Constitution.

"Since the issues in this case are of nationwide importance and present substantial federal question of first impression together with constitutional issues, it is respectfully requested that this court grant the petition for a writ of *certiorari*."

How Fast Are We Developing Nuclear Process Heat?

How near is the AEC to building a high temperature materials testing reactor suited to the development of materials for the 2,500-3,000° F. required for chemical industry use? "Not very close, under present circumstances," explains AEC's director of Civilian Reactor Development, W. Kenneth Davis. "The Commission, with the Bureau of Mines, has for some time been interested in high temperature reactors. Actual, specific studies were asked for by the AEC. I would say we have looked at the whole matter pretty thoroughly and regard the attaining of an operating reactor in but a few steps, highly speculative. We are engaged in a program of getting at first things first, with emphasis on the civilian power field. High temperatures will be achieved through a long range, expensive project. We prefer steps involving increments of a few hundred degrees, instead of trying for a thousand."

Nuclear Development's two-region high temperature reactor, featured in the recent Chicago symposium and discussed by Gamson in this issue, was the result of a design study conducted for AEC. Cost would be $25 million; purpose would be for development of fuel elements only.

Thermonuclear Race?

The jointly announced U.S.-British achievement in containment of highly excited atomic nuclei has been described in some quarters of the press as a "race" to be first with thermonuclear power, with the Soviet Union a major contender. In commenting on this recently, Henry DeWolf Smyth, speaking as president of the American Physical Society, said: "This is unfortunate. The situation is more complicated than that. What has been achieved so far is merely the first stage in a long, long period of study . . ."

Washington Concentrates on Science

The past few weeks have shown Washington's determination to get under way with various scientific programs and activities. A science advisor to the Secretary of State has been appointed. A bill establishing a Federal Department of Science of cabinet rank has been introduced in the Senate . . . the first Science-Military Dinner ever to be on the official White House social calendar was attended by 70 per cent scientists, 30 per cent military . . . a space program has been launched . . . and a large scale foreign literature translation-dissemination service is in the works—if $300,000 can be made available for that purpose.

For State

Wallace R. Brode has been named to head the newly established Office of the Science Advisor to the Secretary of State. He indicates that "an important function of this office and the embassies will be to integrate science and engineering areas within our national policies . . ."

The Killian Function . . .

In spite of the merry-go-round of activity involving scientists and technologists, the precise function of the office of President Eisenhower's special assistant for Science and Technology, James T. Killian, is still somewhat obscure. Here are visible evidences of what is shaping up, however: Killian's office is in the process of organizing a series of advisory panels, to be made up of outstanding persons representing fields of specialty. At present, a panel is being set up on education and manpower. Another is on scientific information.

The Dept. of Commerce . . .

While this latter panel is being established, the Commerce Department, doubtless with Killian's concurrence, has proposed to establish a Foreign Technical Information Center. Prompt action for setting-up this program is provided for in a $300,000 supplemental appropriation request transmitted to Congress by the President on January 22. In addition, the President's budget for 1959 includes $1.25 million for the program. Plans include setting up of a clearinghouse for all technical and scientific information using present translation activities regardless of who is doing the work—private or government. Items will be cataloged by the Office of Technical Services; abstracts will be published and released to the technical press, and copies of the translations will be made available to the public. In its coordination activity, the new Center would endeavor to eliminate duplication of translating—even among friendly foreign governments. It is estimated that 50,000 abstracts and 10,000 complete translations will be supplied.

More recently, a private firm in New York City has announced an agreement whereby the Soviet Government will exclusively supply early copies of important periodicals and books to this firm for re-publication within six months after receipt.

. . . And The Dept. of Defense

At a recent press conference, President Eisenhower explained that he is setting up to handle our space problems by two separate actions. One of these adds further to the responsibilities of Mr. Killian, who the President has asked to get together the scientists necessary to give the U.S. a

(*Continued on next page*)

For Education . . . A Busy Month

The Yale Conference of the President's Committee on Scientists & Engineers came up with the following: called for a new attitude toward science and education on part of both public and government . . . a marked improvement in the quality of education, with more rigorous programs . . . more money for basic research . . . that liberal arts not be sacrificed to a scientific program . . . military security should not hamper scientific communication between countries . . . continued scientific cooperation and assistance to other free nations.

It is beginning to look as if the President's education program bill may be substantially adopted. In Congress, one group (largely Democratic) calls the scholarship proposals too small . . . another group (largely Republican) would sooner see a smaller program of national scholars, each receiving a substantial award, plus efforts to increase private, industrial, and state aid.

In the meantime, John R. Dunning, Columbia's Dean of Engineering, has come out for Federal scholarships, Federal grants to engineering schools to accompany new scholarships, Federal matching grants to help build facilities, and tax revision and subsidies to aid in paying faculties.

Columbia was also in the news by announcing that 25 chemistry majors from selected high school graduates will be permitted to get their Ph.D.'s two years after their B.S.'s.

They'll Do It Every Time
By Jimmy Hatlo
AFTER YEARS OF COLLEGE, PRE MED, MEDICAL SCHOOL, INTERNSHIP AND WAITING FOR PATIENTS, DOC'S HOUSE FEE IS ....
YOU'RE WONDERFUL, DOCTOR! YOU'VE REALLY PULLED HIM THROUGH! I WANT TO PAY YOU NOW— HOW MUCH IS IT?
THAT'LL BE $5—
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B-BUT—YOU JUST PUT A WASHER IN THE FAUCET AND HUNG A CURTAIN ROD—
YEAH— THAT'LL BE $14.95!!
BUT THE HANDYMAN WHO FOUND A PAIR OF PLIERS AND WENT INTO BUSINESS LAST MONTH ....
THANX AND A TIP OF THE HATLO HAT TO BOBBY KARL, KANSAS CITY, MO.
JIMMY HATLO
2-5
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SCOPE

Washington & Engineers

(*Continued from page* 21)

program of outer space achievement in the scientific area, as distinguished from defense aspects which are to be handled under the direction of an assistant to Defense Secretary McElroy.

Shortly afterwards, McElroy announced the appointment of Roy W. Johnson, a G-E executive, who says he is an administrator, and that "I have a way with scientists." (See Washington Feedback).

Killian's Advisors

Killian's main advisory group is known as his Science Advisory Committee. Its membership is as follows: J. H. Doolittle, Shell Oil . . . R. F. Bacher, Cal. Tech. . . . E. M. Purcell, Harvard . . . Herbert York, U. Calif. . . . G. B. Kistiakowsky, Harvard . . . D. W. Bronk, National Academy of Sciences . . . L. V. Berkner, Assoc. Universities . . . C. P. Haskins, Carnegie Institution . . . J. R. Zacharias, MIT . . . W. O. Baker, Bell Labs . . . H. A. Bethe, Cornell U. . . . E. H. Land, Polaroid . . . H. P. Robertson, Cal Tech . . . I. I. Rabi, Columbia U. . . . J. B. Fisk, Bell Labs. . . . J. B. Wiesner, MIT. . . . and D. Z. Beckler, executive office of the Science Advisory Committee.

Appointments

A science advisor to NATO has been appointed. He is Norman Foster Ramsey, a physicist from Harvard University. He will report directly to Secretary-General Paul-Henri Spaak. The appointment developed from a decision at the recent NATO meeting that the 15-member alliance should pool its scientific talent, research, and techniques for the common defense. The NATO Council is next expected to name a scientific committee made up of representatives from the member nations. This group is to work closely with Mr. Ramsey, and is to make recommendations for action on a French proposal for a Western Foundation for scientific research.

Army's new Research chief is Lt. Gen. A. G. Trudeau, replacing General Gavin, who retires March 31. Trudeau has been commanding the I Corps in Korea, has had a long and varied military career.

brainstorms

CEP's Forum for Untested Ideas

WHY NOT FIX NITROGEN DIRECTLY?

Ever since the first synthetic ammonia plant went on stream using hydrogen generated from coke, the chemical industry has found itself in the curious position of having to throw away perfectly good carbon just to get hydrogen. The hydrogen is then reacted with nitrogen to form ammonia, and the ammonia (or some product such as ammonium sulfate, ammonium nitrate or urea) is applied to the soil for fertilizer. Actually all that is wanted is the nitrogen, which abounds in the air, and even the hydrogen combined with it is ultimately wasted. Now that the bulk of the ammonia in this country is made from natural gas or heavier hydrocarbons, we find ourselves in the position of discarding all the components of these valuable natural resources just to fix the elusive nitrogen. Actually, the amount of carbon dioxide produced in a day's time in an ammonia plant is greater in weight than the ammonia produced and most of it is wasted.

Other methods of fixing nitrogen from the air have been tried over a period of years, and although they have proved technically successful, they are not economical. Early in this century the Birkeland-Eyde process was used to produce oxides of nitrogen by blowing air over an electric arc. Within the last few years the Wisconsin process accomplished the same thing using pebble stoves at high temperatures. More recently we have read reports of the successful fixation of nitrogen at RPI using nuclear radiation techniques.

What I propose, however, would eliminate the need for capturing this nitrogen in some form that can be packaged and then spread on the ground. There must be some way we can activate nitrogen directly in the air into a form that will react with the soil. One could visualize a tractor-drawn rig which contained a blower, a reaction chamber, and some plows similar to those used for direct application of ammonia to the soil. The blower would force air through the activation chamber and down into the ground. The activated nitrogen would react directly with the soil and thus become fixed. It would be just as easy as today's direct application ammonia techniques but would require only air as the fertilizer material.

The problem, of course, is what to put in the reaction chamber. It might be a catalyst, a radiation source, or almost anything that would produce nitrogen oxides or nitrogen activated in some way to make it at least temporarily reactive with the soil. This is the problem I dedicate to all brainstormers. Figure out how to do this and you will not only make nitrogen fixation a do-it-yourself project for the farmer, but you will be conserving millions of tons of carbon in the form of coal, oil, or natural gas that is now being virtually wasted.

Norman C. Updegraff
Louisville, Kentucky

More Societies May Share Engineering Center

Sixteen additional engineering societies have been invited into the new United Engineering Center in New York, to join with the five Founder Societies in occupying the building in 1960. Meanwhile, demolition is under way at the site, and construction is expected to start next summer. Fund raising is proceeding on schedule and contributions to date are encouraging. The Greater New York City Commerce Campaign will soon be in full swing with Mayor Robert Wagner as Honorary Chairman of the drive which is headed by William H. Byrne, vice-president of ASME. On the publicity front, two models of the proposed building design have been constructed and are available to Societies for display at their meetings.

$ In Low Temperature Processing

Two years ago sales were $10 million. Last year they were up to $35 million. This is the record of Air Products, Allentown, Pa., a firm which supplies low temperature gas producing plants to the process industries. Among the other achievements of this firm is that it produces over 90 per cent of the LOX used in the government's missile testing program.

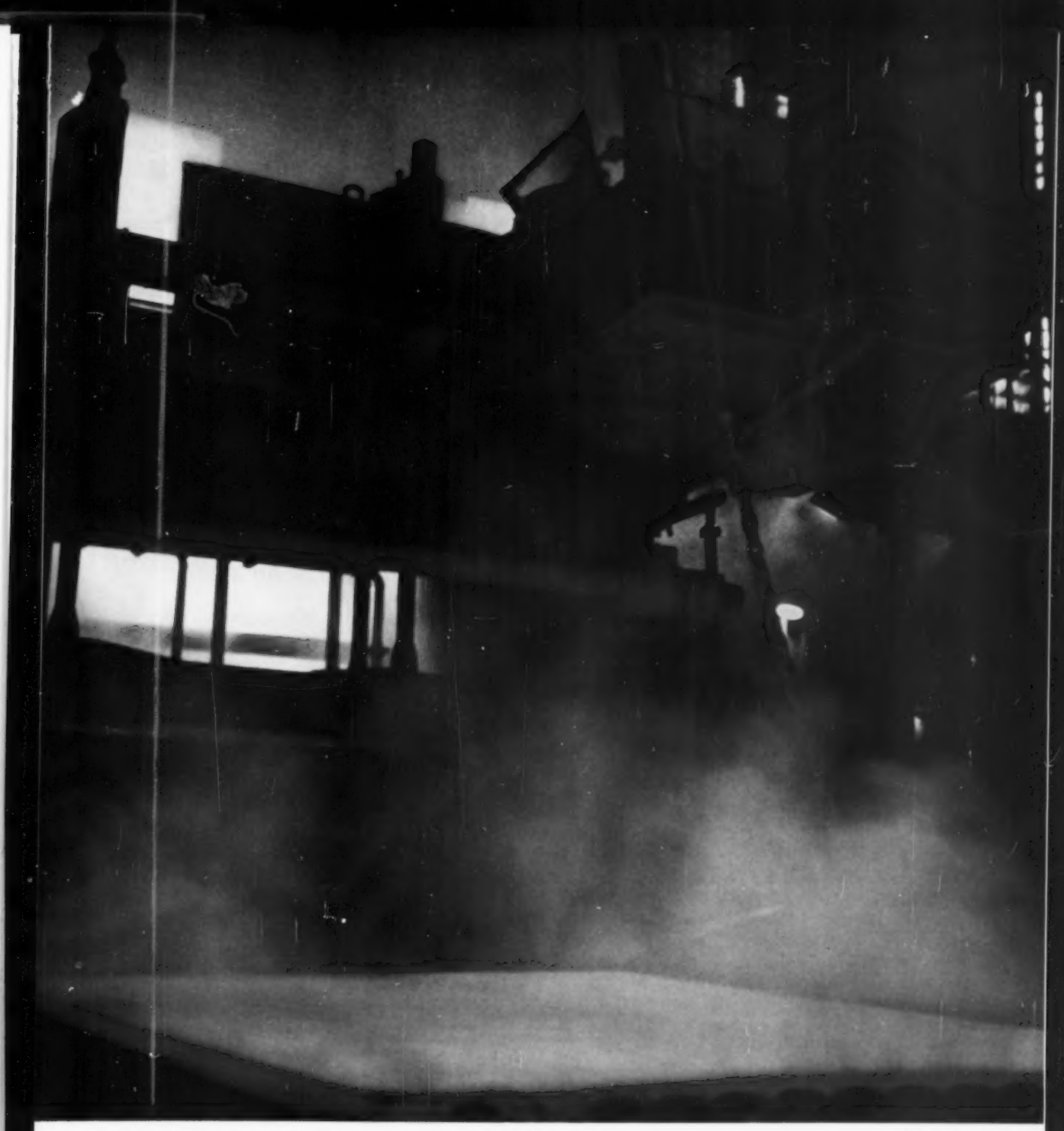

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Photo by d'Arazien

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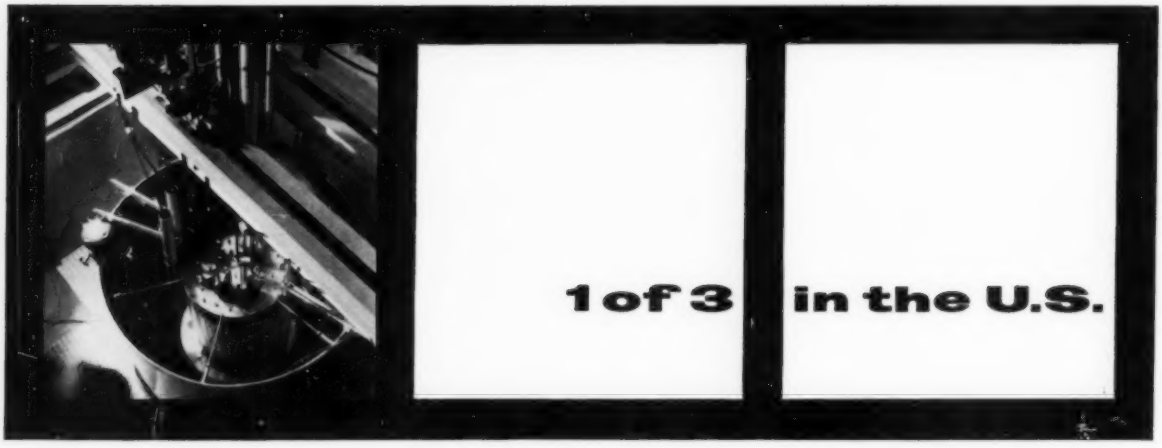
On December 10, 1957, Martin officially commenced operation of an important new facility in the field of nuclear research and development.

This was the date of criticality of the Martin Nuclear Experiment Facility – one of only three privately owned and operated critical test installations in the United States. Martin activities in the nuclear field now are in their fourth year. The new facility is the result of a long-range program for the establishment of complete research and testing capabilities to augment the development and manufacturing assets of a fully integrated Nuclear Division.



Martin nuclear activities encompass the research, development, manufacturing and testing of reactors, fuel elements and related components for industry, the Atomic Energy Commission and all branches of the military.

(Photo above) Now under zero power test at the facility is a full core of stainless steel tubular fuel elements for the MARTIN Air Transportable Power Reactor.

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Materials Investigations & Analyses
Powder Metallurgy
High Temperature Reactor Components
Shielding

PROBLEM ON HIGH TEMPERATURE, NON-POISONING BRAZING RECENTLY SOLVED BY ANP MEN:

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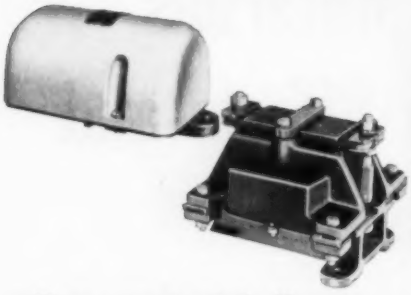
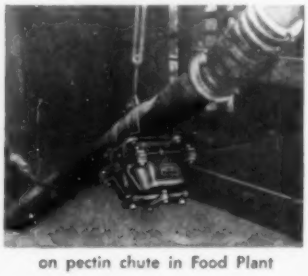


on Packaging Machine Hoppers

on Pellet Making Machine



on pectin chute in Food Plant

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about our authors

R. L. Wright and **D. E. Kirsopp** give us in this issue their experiences with "Pond Surface Cooling of Chemical Plant Cooling Water." Both are members of the Utilities Department technical staff for the Seadrift plant of Union Carbide Chemicals, have gone into engineering work from their original specializations in chemistry. The article this month reports on what the Seadrift plant did to stay in production during a period of water shortage. Institute members Wright, a native Texan, and Kirsopp, a Texan by adoption, feel that in a small way they have assisted in helping solve the Texas water problem.

Organizing for effective maintenance can be quite a job, but **F. D. Macy** appears to have licked the problem for Shell Oil at Houston. Macy has been working in this field for about fifteen years, has seen the concept of industrial engineering grow from the pioneering stage. Author Macy feels that his best efforts have been directed toward relating the human endeavor—operating, controlling, and maintaining—to chemical reactions and operations. His work has developed techniques for measuring and evaluating the operator's job which have made continuous operations more effective and productive. As indication that industrial engineering methods are growing in complexity, Macy cites such new statistical tools as linear programming, waiting line theory, and Monte Carlo methods —all applied to the solution of refinery problems.

Wright

Kirsopp

Macy

Further light is cast this month on pilot plant development of processes by the article on Phillips' Marlex 50 polyethylene (authors **E. W. Mellow, R. E. Weis, M. R. Cines,** and **G. H. Dale**). The four worked together on the project through the experimental work, reactor development, and pilot plant stages. Mellow is now manager of the Plastics Section, which was formed when the project reached the semi-works plant stage.

For this month's roundup of the chemical engineering aspects of nu-

(*Continued on page* 36)

IN MIXERS...tough buyers look at the bearings

Specifically, they look for oversize, heavy duty, high capacity bearings like the ones in this Philadelphia Mixer.

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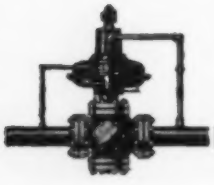

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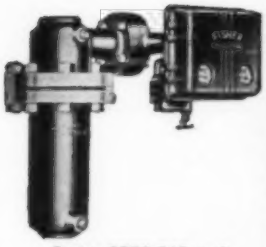

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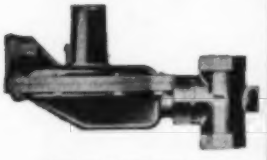

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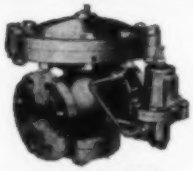

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Nuclear Reactors: the Chemical Engineering Aspect

Nuclear Chemical Engineering, Manson Benedict and Thomas Pigford. McGraw-Hill Book Company, Inc., (1957), 594 p., $9.50.

Reviewed by L. H. Roddis, Jr., Deputy Director, Division of Reactor Development, Atomic Energy Commission, Washington, D. C.

This volume is one of the McGraw-Hill series on Nuclear Technology and, as such, fills an important gap in the literature. There are a substantial number of books in print in the nuclear engineering field which emphasize reactors and the mechanical or electrical engineering side of the problem. To the best of my knowledge, this book represents the first really comprehensive text on the chemical engineering aspects of the problem.

The book is written basically as a text for graduate study and, to be useful, requires an adequate background in basic mathematics, physics, chemistry, and chemical engineering. In twelve chapters four general subjects are covered. The first two chapters are general introductions to the over-all nuclear and chemical engineering problems in the atomic energy field. The third, fourth, sixth, seventh, and eighth chapters cover the over-all fuel cycle in several types of power reactors from uranium extraction through chemical separation of irradiated fuels. The last four chapters are devoted to an extremely comprehensive treatment on the separation of isotopes, both light and heavy elements, and constitutes the first thorough textbook treatment of this important field. One chapter, chapter 5, is devoted to the extraction problems of three materials, zirconium, thorium, and beryllium, which are important in the nuclear energy field.

The authors of the book are well qualified to write in this field. Dr. Benedict is Professor of Nuclear Engineering at Massachusetts Institute of Technology and was formerly Chief of the Office of Operations Analysis of the U. S. Atomic Energy Commission. He has been active in the atomic energy field since the very first days. Dr. Pigford has also been active in the atomic energy field for a long period of time, having been at Oak Ridge, then Associate Professor of Nuclear Engineering at Massachusetts Institute of Technology, and now Chairman, Department of Reactor Engineering, General Atomics Division of General Dynamics Corporation. It is particularly refreshing to find a text which approaches the problems on an over-all system basis, which is the inherent approach of chemical engineers to the problem, rather than the individual approach to specific problems too often exhibited by others.

It is hoped that the authors will continue to enlarge on this book in subsequent editions as more information becomes available both through the acquisition of new knowledge and through the further release of existing information so that the comprehensive text may continue its usefulness.

Geneva Series

Nuclear Power Reactors. Edited by James K. Pickard. D. Van Nostrand Company, Inc., New York.

Reviewed by Clark Goodman, Assistant Director for Technical Operations, Reactor Development Division, Atomic Energy Commission, Washington, D. C.

This is the sixth and last book to appear in the Geneva Series on The Peaceful Uses of Atomic Energy edited by James G. Beckerley, former Director of Classification of the U. S. Atomic Energy Commission. As a highly respected consulting engineer on atomic energy developments, James K. Pickard is well qualified to select, from the many excellent papers presented at the Geneva Conference in 1955, those which dealt in logical fashion with the over-all technical problems of the development of useful atomic energy. Accordingly, this volume is limited to reactors as a source of heat for electric power production.

The nine chapters cover the content of more than fifty papers in a book of slightly under 400 pages. After three well-knit chapters on Nuclear Power Prospects, Nuclear Fuel Cycles and Reactor Types, and Economics of Nuclear Power, concise descriptions are given of those reactor types currently under development. The pressurized- and boiling-water types have been given more extensive coverage because of the editor's conviction that these "hold the best promise of providing practical atomic power for the next ten to fifteen years."

In reading the excellent descriptions of the PWR and EBWR, it is gratifying to know that instead of the future tense the authors would now be able to speak with even greater assurance in the present tense. Likewise, the sodium-graphite experimental reactor at Santa Susana, California, and the dual purpose gas-cooled reactors at Calder-Hall, England, are rapidly becoming part of the history of nuclear energy developments. Only when the reader comes to Chapter 9 on Fast Reactors does he find that most of the predictions are still in the future.

It sometimes seems to this reviewer that atomic power is arriving at a snail's pace. Thus, it comes as a pleasant surprise in reading this book to realize how much progress has been made during the past three years since the summary papers, on which this volume is based, were written.

Glossary of Nuclear Terminology

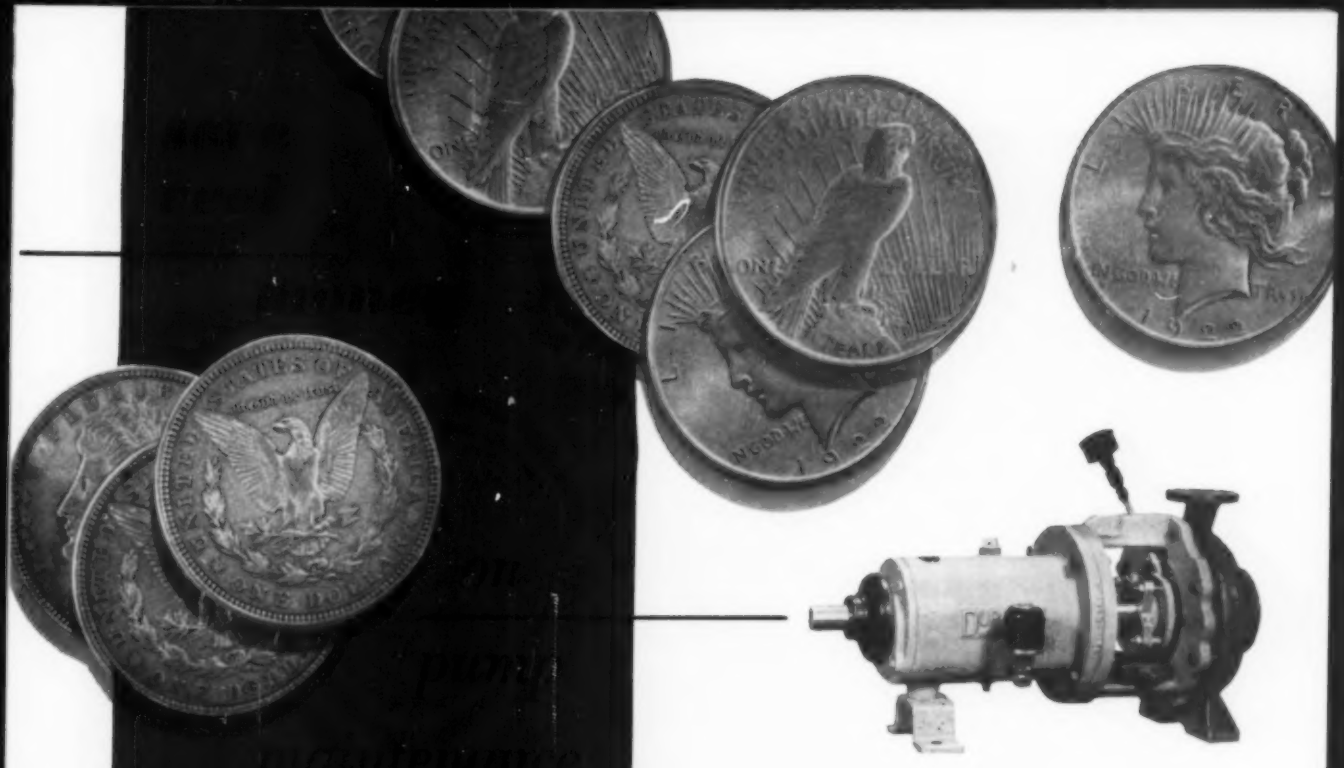
Glossary of Terms in Nuclear Science and Technology, (American Standard N1.1-1957), 181 p., $5.00. American Society of Mechanical Engineers, New York, or American Standards Association, New York.

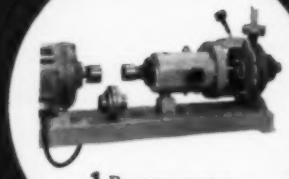
Designed to provide a common language among medical men, engineers, chemists, physicists, biologists, etc., working in the nuclear field. Definitions, tables, charts, and formulas are included where necessary.

Belgrade Power Conference

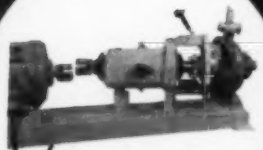
Transactions of Sectional Meeting, World Power Conference, Belgrade, Yugoslavia (June, 1957). Delivered in the U.S. at $150 a set.

"Energy as a Factor in the Development of Under-developed Countries" was the theme of this Belgrade meeting. The *Transactions* contains all reports of the meeting, including all technical papers and discussions of same, all speeches at the formal opening and closing sessions, and a list of all delegates, participants, and accompanying persons. (Available through the Secretary, U. S. Committee, World Power Conference, 29 W. 39 St., New York, N. Y.)





1. Remove spacer from coupling.



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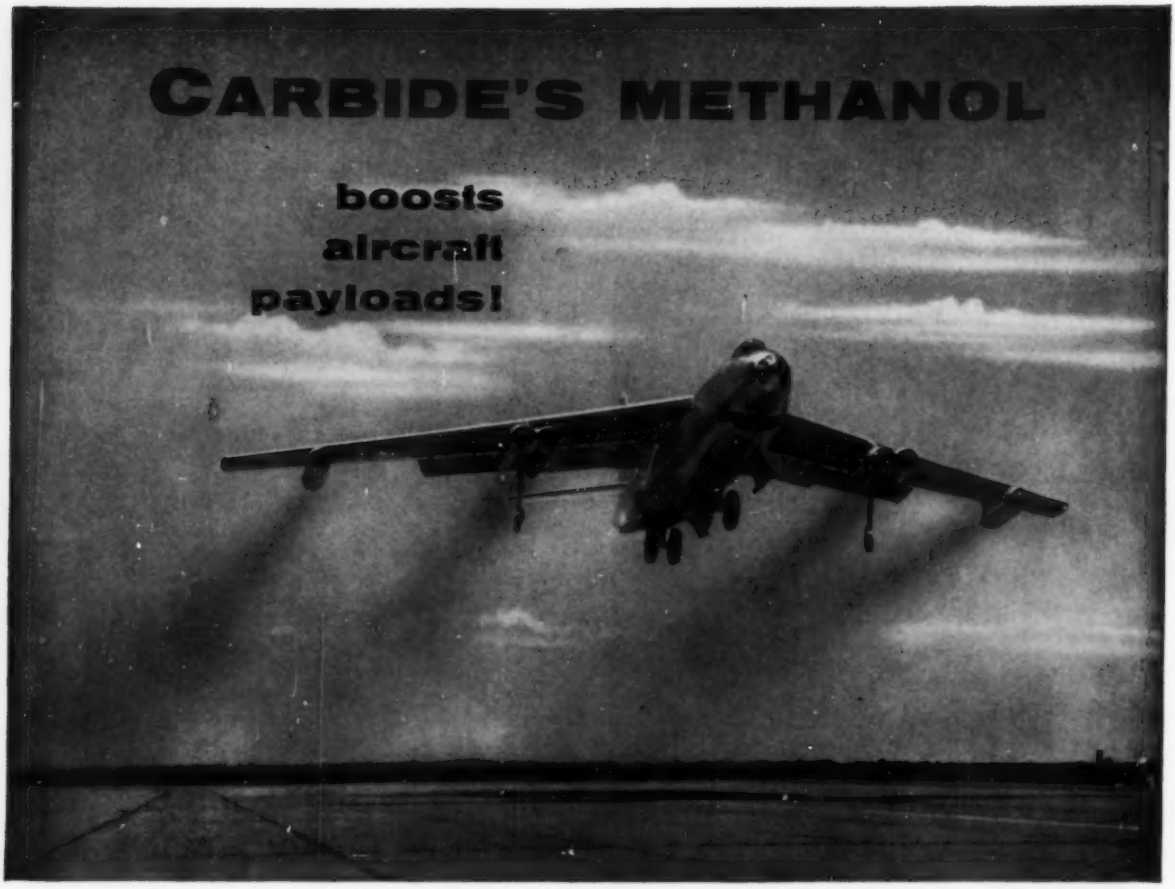

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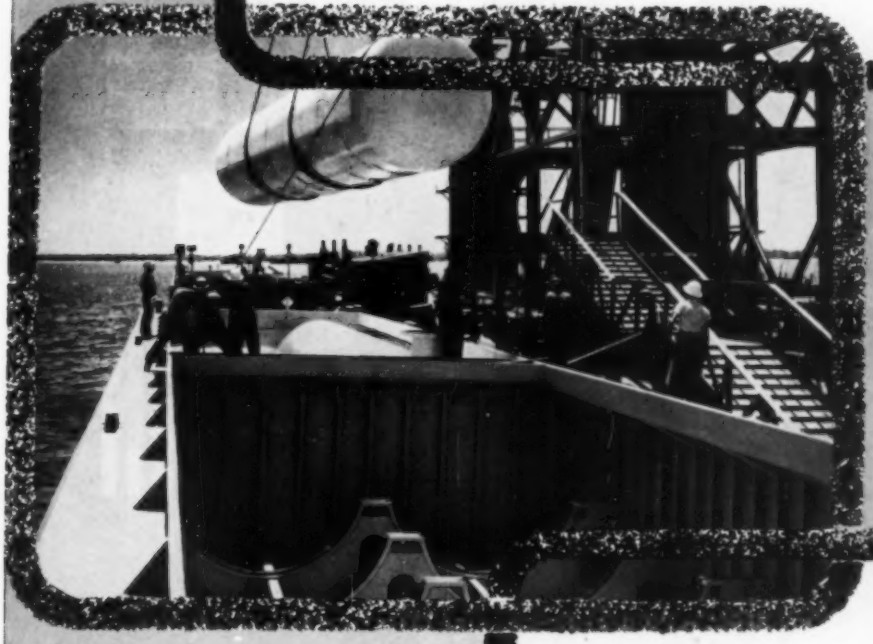

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ATOMS FOR INDUSTRY

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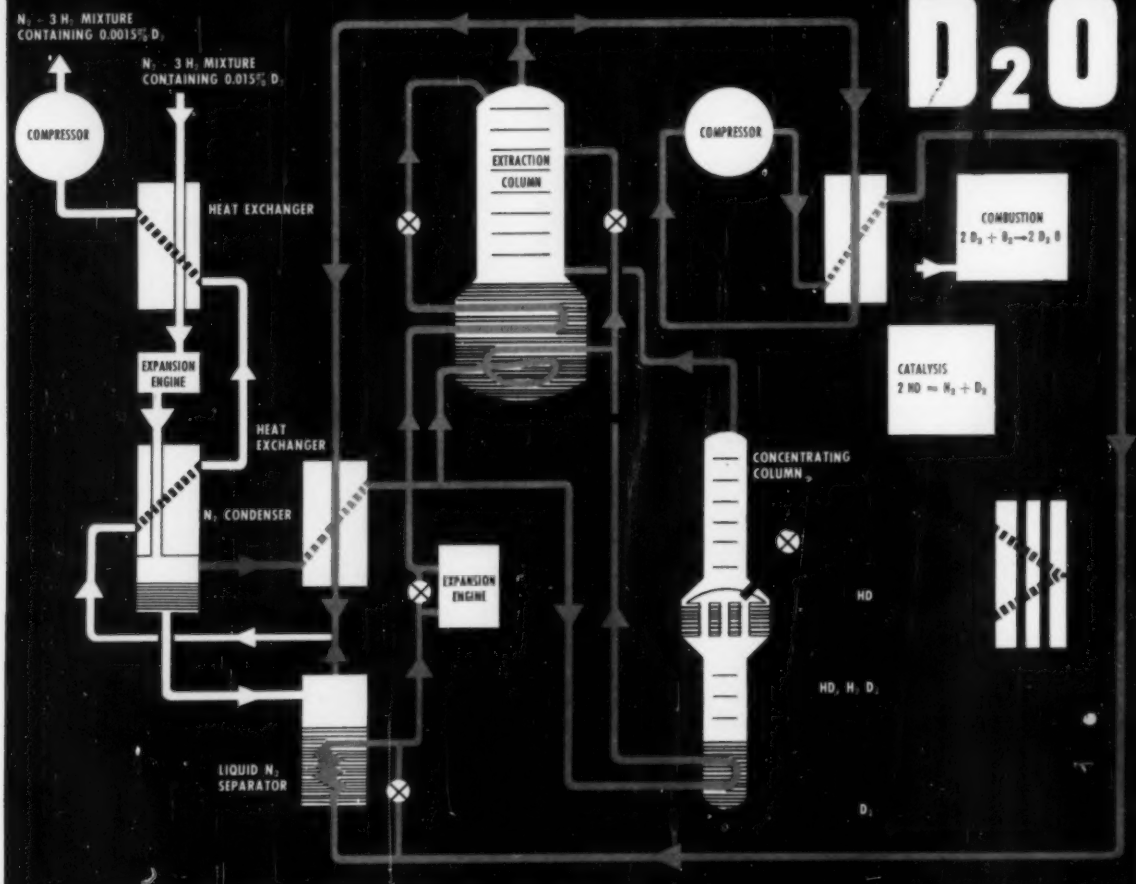
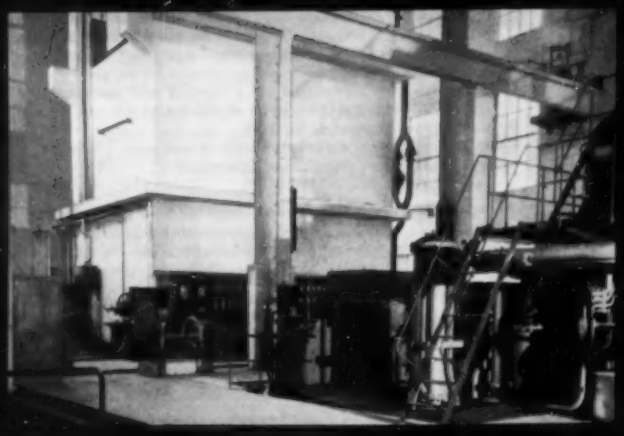




A schematic of a heavy water plant designed by Air Liquide. This plant is required to treat the hydrogen contained in the synthetic ammonia mixture $N_2 + 3H_2$ in order to extract deuterium, later synthesized to heavy water by combining it with oxygen.

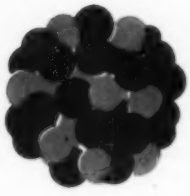
General view of the hydrogen rectification plant mentioned on the page opposite.

CONTROLLING ATOMS FOR INDUSTRY

with smaller, more efficient piles using heavy water as a moderator.

Heavy water, in demand as a highly efficient and economical moderator of neutron activity in atomic reactors, is now being produced by low-temperature liquefaction and fractional distillation in a plant designed and built in France by Air Liquide — *the only heavy water plant of this kind in the world.*

The development of the heavy water plant is a logical extension of the liquefaction methods and techniques perfected by AIR LIQUIDE over the past half century and used throughout the world for numerous applications in many fields (see paragraph in margin below). For example, in North America alone 2000 tons of oxygen and 2000 tons of ammonia synthesis mixture are delivered every day by AIR LIQUIDE units, designed and built in North America.



American Air Liquide will be pleased to consult with representatives of industries, utilities or government agencies concerning this new heavy water production process as well as any problems capable of solution by the application of our liquefaction and fractional distillation techniques.

Enquiries should be addressed to American Air Liquide Inc., Chrysler Building, 405 Lexington Avenue, New York 17, N.Y. Telephone: YUkon 6-6544.

THE PROBLEMS which have been solved by Air Liquide, and which have gradually led to temperatures as low as 20°K necessary for heavy water production are:

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Natural gas liquefaction
Pure CO production
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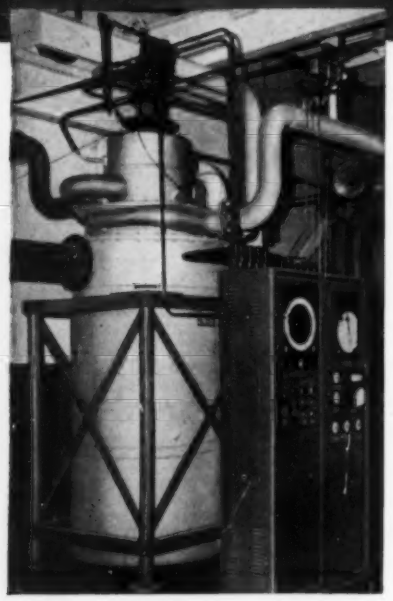

a compact means of heating air or process gases for testing or production

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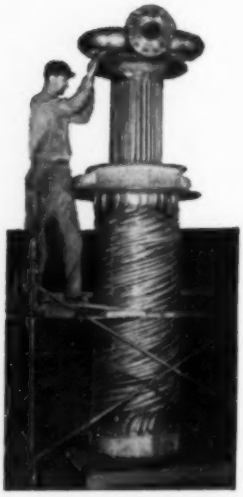

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About our authors

(*Continued from page* 26)

clear energy, *CEP* has corralled a group of able commentators in important areas such as reactor development, radiation processing, and nuclear process heat.

Raymond E. Vener, who leads off the special nuclear articles in this issue, performs a number of functions in his connection as process engineer with Catalytic Construction Co. of Philadelphia. But in spite of maintaining a high level of activity on the job, Ray manages to devote time to important A.I.Ch.E. activities—presently as chairman of the 50th Anniversary Subcommittee. A teacher (Drexel Institute) of graduate as well as undergraduate courses, Ray speaks with authority on the subject of education in his article, is particularly anxious to stress that:

"The vast bulk of atomic energy activities is definitely not to be considered 'nuclear engineering' or 'nuclear science.' Practically all of it should be classified by technical societies, publishers, and engineers in terms of the basic engineering and scientific disciplines with appropriate absorption of nuclear phenomena.

"The 50 years' evolution of chemical engineering as we know it in the U. S. should be studied by those involved in blending and evolving the one basic new field—engineering physics."

Ray, who has authored numerous papers and addresses, causes us to remember that about a year ago, he wrote in a somewhat more "bullish" frame of mind about industry's immediate prospects in the nuclear field than he does at present. The article presented herewith is based on a talk Ray gave recently before A.I.Ch.E.'s Rocky Mountain Section.

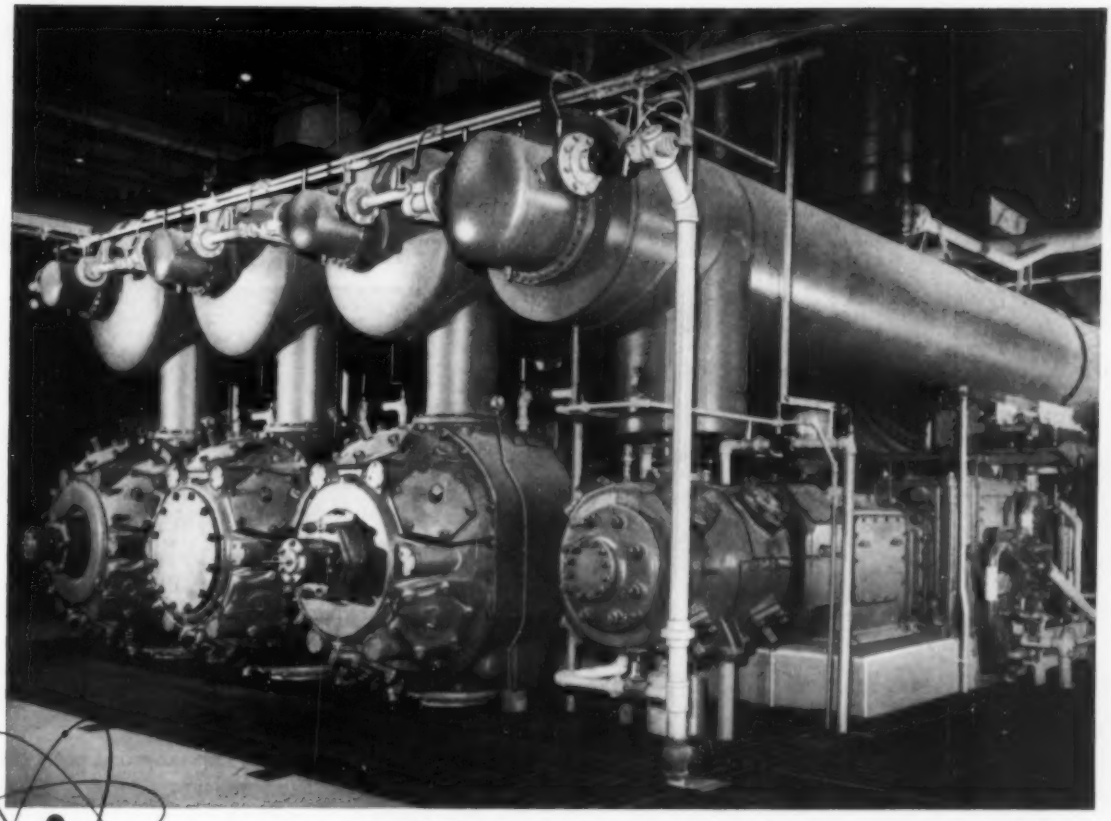
George F. Jenkins, author of "Time to Shift the Emphasis," is well known to *CEP*'s readers. For the past several years manager of chemical processing for Union Carbide Nuclear Co., George speaks with a vast experience about the nuclear field. Before tackling the nuclear assignment for his firm, George spent several months at Brookhaven "getting the atom in perspective." Now, as staff assistant to the vice-president of Union

(*Continued on page* 40)

Vener

Gamson

Martin



Two Clark CLBA-8's serve in connection with the Engineering Test Reactor designed and built by Kaiser Engineers, Oakland, Cal., for the AEC's National Reactor Testing Station at Idaho Falls, Idaho.

In ATOMIC ENERGY too, Clark Compressors Are Giving Rugged, Reliable Service

Designed to perform engineering tests on fuel elements and components of nuclear plants, the Engineering Test Reactor provides large experimental facilities which supplement research reactors already in use.

Serving a major experiment in this reactor are two Clark CLBA-8 compressors, rated at 4,500 bhp. each. With a capacity of 15 pounds per second, they are operating at a discharge pressure of 320 psig. A 13-step combination automatic and manual pressure control allows varying discharge pressures from 50 to 350 psig.

These CLBA-8's, built on the Clark-originated balanced/opposed principle, provide maximum power on less fuel in minimum space. Their field service records in a wide range of applications attest to their high efficiency, economy of operation, and low installation and maintenance costs.

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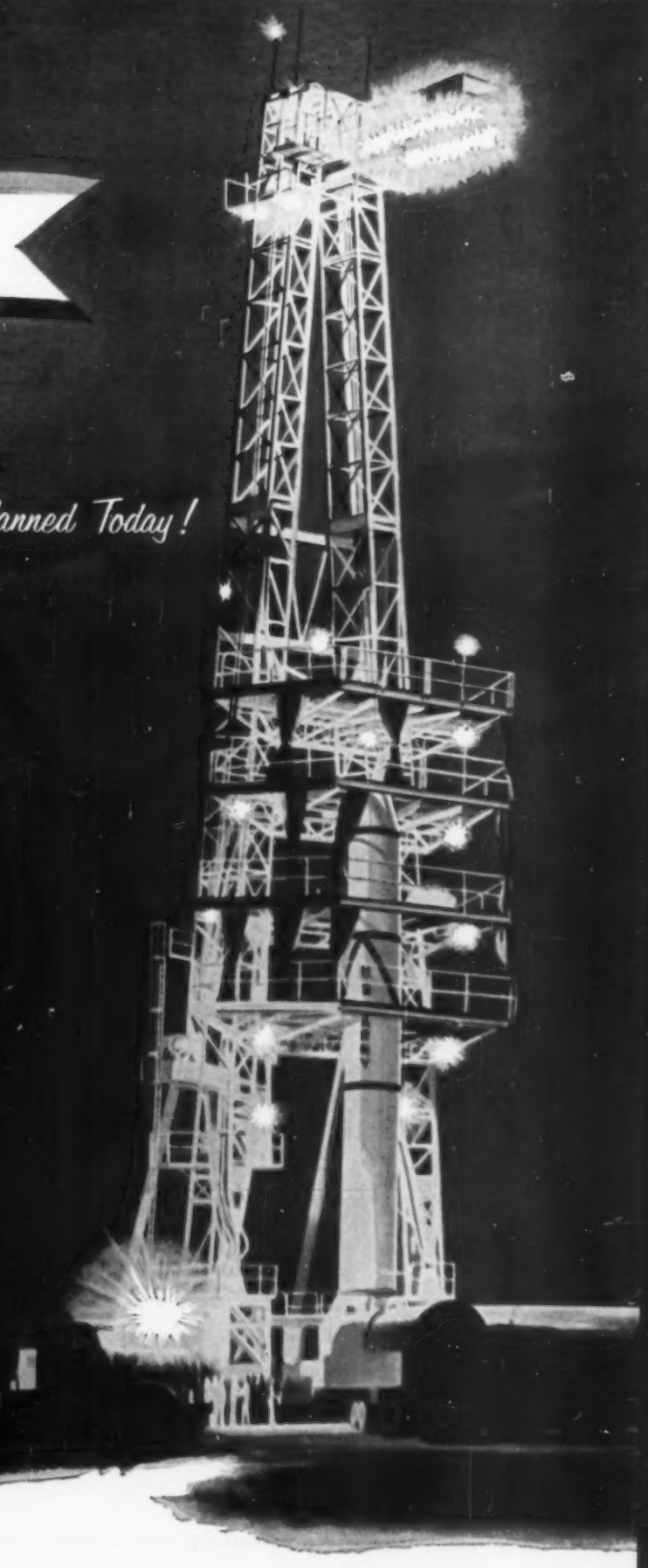

OTHER IMPORTANT DEFENSE APPLICATIONS OF DRESSER PRODUCTS AND EQUIPMENT

Dresser Manufacturing Div. supplies flashwelded connecting rings for powerful jet engines used in military aircraft. Some types of aircraft engines require as many as 85 Dresser rings.

Roots-Connersville makes compressors and blowers for atomic submarines; gas pumps for atomic energy installations; blowers for "lifting bag" inflation to raise crashed aircraft.

Clark Turbo-Mobile power plants, rail-mounted, supply emergency electricity for Navy Yards, docks, hospitals, and major disaster areas. Unit has capacity of 6750 kilowatts, enough power for a city of 12,000.

High pressure compressors from Clark . . . instrumentation and other electronic equipment from Southwestern Industrial Electronics . . . are used in guided missiles and many other important military applications.

Dresser-Ideco supplies structural equipment used in military defenses, including radar outposts for our remote Arctic warning system as well as microwave, radio and television towers.

Pacific provides the Navy with Turbo pumps for ships' main and boiler feed pumps. Equipment from other Dresser companies is also used on both merchant ships and naval vessels.

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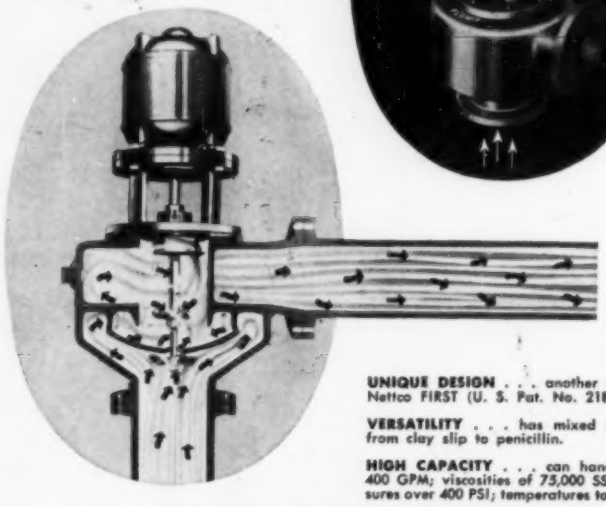

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About our authors

(*Continued from page* 36)

Carbide International Co., George is literally touring the world. After several weeks in Europe studying the chemical industry, followed by several weeks rechecking the American scene, he is now off to Australia. If George's experience is any criterion, it might today be possible to say, "join a chemical company and see the world."

Another author ranging far afield—though not quite as far as the one just reported—is **Bernard W. Gamson,** associate research director for Borg-Warner, Chicago. Bernie put together the Annual Meeting Symposium on Nuclear Process Heat, and did such an analytical job of planning and organizing the session that *CEP* asked him to assemble this issue's general resume of the subject. Not one to be unduly over-optimistic on a subject which he sincerely believes will require a lot of work ahead, Bernie attempts in his article to give an unbiased picture to his readers. As a human interest note, it should be reported that while *CEP* was busy with the details of processing the article, Bernie was on an extensive field trip in the West, managed to catch a "bug" which flattened him in the Los Angeles Statler for a few days. So it turned out that, for once, *CEP* had its author under an "absolutely certain" communications setup for proof OK's, etc.

One of the pioneers in radiation processing is **Joseph J. Martin,** professor of chemical engineering at the University of Michigan. Having the advantage of the nearby reactor at the Phoenix Project, operated by the University, Joe has directed a great deal of research in this field, and has produced a number of authoritative papers. Notwithstanding, he has managed to give freely of his time in the affairs of A.I.Ch.E.'s Nuclear Engineering Division, in which he served as secretary from its inception up until this year. Joe also organized a highly successful symposium on radiation processing for the recent Annual Meeting, and was asked by *CEP* to prepare the article in this issue, reviewing the progress in the field, and pointing out what to expect in the future.

T. J. Hardwick, who with **R. P. Nejak** writes on radiation in the petroleum industry, is head of the Radiation Chemistry Section of Gulf Research & Development, where Mr. Nejak is also a staff member. Their article is the best we have seen on the activities in a field known to be intensely busy studying radiation effects.

ADVERTISEMENT—*This entire page is a paid advertisement* *Prepared by U. S. Industrial Chemicals Co.*

U.S.I. CHEMICAL NEWS

February ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1958

U.S.I. in New Company to Develop High Energy Fuel

A new company has been formed to carry out process development and semi-pilot plant work on a high energy, boron-based fuel, under Air Force contract. The company, AFN, Inc., is owned one-third each by American Potash, Food Machinery, and the U.S.I. Division of National Distillers.

The combined resources and knowledge of the three participating companies cover almost the entire chemical industry. U.S.I. produces sodium, polyethylene, alcohols, special metals, and a large variety of other chemicals. American Potash makes boron chemicals, lithium, chlorates, perchlorates, and many other products. Food Machinery supplies alkalies, phosphates, peroxygen chemicals, insecticides, among other products.

The initial work will be carried out at Henderson, Nevada.

Ammonia, Sodium Metal Used for Recovering Pure Anhydrous Hydrazine

A solution has been found to the difficult problem of separating ammonium chloride from hydrazine made by the oxidation of ammonia with chlorine. The patented process provides for the addition of metallic sodium in anhydrous ammonia to the mixture of hydrazine, anhydrous ammonia and ammonium chloride.

The sodium reacts with ammonium chloride to produce ammonia, hydrogen and sodium chloride. Since salt is relatively insoluble in liquid ammonia, most of it precipitates out as a solid which can be removed easily by filtration, decantation or other similar means. A solution of hydrazine in liquid ammonia remains, from which pure hydrazine is readily recovered by fractionation.

Yields in the order of 97% have been obtained by adding an amount of sodium exactly equivalent to the chloride ions present. The reaction proceeds at room temperature.

U.S.I. is a producer of metallic sodium and anhydrous ammonia, both of which are used in this process.

Metals Can Now Be Melted While Suspended in Space

A new technique called levitation melting permits researchers to prepare small specimens of metals and alloys with purity levels difficult to reach by ordinary means. The metal or alloy is placed in a high frequency AC electro-magnetic field which causes it to float freely suspended in space, and to melt.

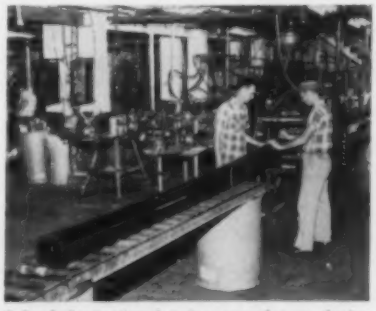
The process uses no containing vessel, and proceeds in an inert atmosphere, eliminating sources of contamination. Melting is achieved in seconds, and electro-magnetic stirring action gives thorough mixing of the melt.

MORE

Longest Polyethylene Pipeline Carries Brine Between Process Plants at Ashtabula, Ohio

Pipe Made of U.S.I. PETROTHENE® Resin Runs for 6,200 Feet From Mallory-Sharon Metals Plant to U.S.I. Sodium Plant

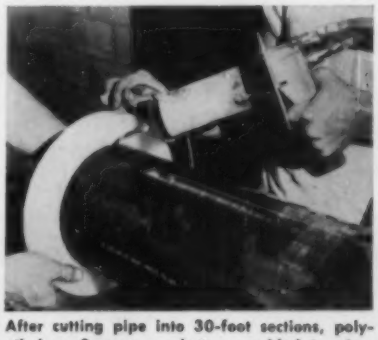
When the problem arose of moving a corrosive solution of saturated brine over 6,200 feet of terrain broken by roads, streams and railroad tracks at Ashtabula, Ohio, U.S.I. decided to use a polyethylene pipeline. Polyethylene was chosen for the job after a thorough study of other materials such as plastic-lined iron, rubber-lined steel and polyvinylchloride. It has the advantages of corrosion resistance, minimum maintenance requirements, ease of fabrication and installation.



Polyethylene pipe leaving extruder at Carlon Products' Asheville, N. C. plant.

Now in operation, the pipe has an inside diameter of six inches, an outside diameter of 7⅛ inches. It is made of U.S.I. PETROTHENE 561 virgin polyethylene compounded with carbon black. The pipe was supplied in 30-foot lengths flanged with polyethylene rings and bolted together at the installation site.

Carrying brine at temperatures ranging from 70 to 90°F, 24 hours a day, 7 days a week, the pipe runs from the brine settling pond at Mallory-Sharon Metals zirconium and titanium sponge plant to the sodium plant of U.S.I.



After cutting pipe into 30-foot sections, polyethylene flanges are hot-gas-welded to pipe.

Steel back-up rings are attached to flanges where elbow meets straight section of pipe.

At site, sections run beneath railroad rest on metal support in reinforced concrete conduit.

After connecting lengths of pipe, line is rolled into trench, needs no further attention.

February ★ **U.S.I. CHEMICAL NEWS** ★ 1958

CONTINUED

Metals Melted In Space

Upon completing the melt, the voltage is lowered, allowing the molten metal to be dropped into a mold. The metal or alloy specimen which results can be used for mechanical testing, metallographic examination, hardness measurements, X-ray diffraction or magnetic studies.

Levitation melting apparatus has been studied at the U.S.I. metals laboratory at Cincinnati, Ohio, for the examination of zirconium, titanium and other special metals.

Levitation melting apparatus in operation. (Photo courtesy Westinghouse Industrial Electronics Department.)

Urethane Foam Can Now Be Sprayed on; It Cuts Insulating Labor Costs

Equipment and techniques for spraying urethane polymer onto overhead, vertical or irregular surfaces, so that it foams and sets in place, have recently been perfected. Insulating coats up to two inches thick can be applied rapidly to vessels, buildings and machinery with no slipping, sagging or falling away of the foam.

In test applications, insulating jobs have been completed in 1/12 the time (calculated in man-hours) required for installing conventional insulating materials. Suppliers of polymer and spray apparatus figure that on ordinary jobs, a trained operator can apply 12 sq. ft. per minute of one inch thick foam.

Since urethane foams are formed by mixing a catalyst with a liquid prepolymer just before application, special spray equipment has been developed which proportions the two materials accurately, and mixes them thoroughly. The polymer formulation itself has been adjusted to meet two opposing types of requirements. It foams and sets rapidly enough to give proper thickness and good adhesion to surfaces. At the same time, it foams and sets slowly enough to avoid clogging of the spray gun.

Flexible and rigid polyurethane foams are produced from the reaction of polyesters with diisocyanates. An intermediate that can be used to produce the polyesters is U.S.I. ISO-SEBACIC acid, a mixture of C-10 dibasic acids.

New Decomposition Unit Regenerates Spent Sulfuric At U.S.I. Sunflower Plant

Sulfuric acid regeneration facilities have recently been added to the Sunflower Ordnance plant operated by U.S.I. at Sunflower, Kansas. The new installation converts spent sulfuric acid into sulfur dioxide for use in the plant's oleum and virgin sulfuric acid production process.

Its design capacity is 70 tons of alkylation spent acid per day. The regenerated sulfuric acid is identical to that produced from sulfur.

The unit has no effluent, uses no water and requires only a minimum of outside fuel. Much of the heat is provided by the hydrocarbons in the spent acid, while natural gas and sulfur supply the balance.

With the addition of these new facilities, the Sunflower plant now has a capacity of 250 tons per day on a 100% sulfuric acid basis.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

Chemical literature is described and classified in a 398-page guide now being sold. Kinds of chemical information are analyzed, ways of keeping current are suggested, use of libraries and indexes is discussed. **No. 1321**

New anionic surface active agent is used in the emulsion polymerization of monomers. It is said to act also as a stabilizer for compounding natural and synthetic latices. **No. 1322**

Polyurethane elastomers are described in a new booklet covering physical properties, thermal stability, low temperature behavior, adhesion, carbon black level, peroxide concentration, solvent resistance. Many charts are included. **No. 1323**

To measure the dielectric constant and dissipation factor of insulating materials, a new analyzer has been developed which is direct-reading, non-destructive. It can be used to inspect incoming materials or machine output. **No. 1324**

Two new silicone compounds designed specifically for production of sponge are now on the market. Claimed to form uniform, unicellular sponges which surpass organic sponges in resistance to ozone and weathering. **No. 1325**

An adhesive consisting of a cyanoacrylate monomer modified with thickening agent and plasticizer is now available in limited quantity. Requires no heat, excessive pressure or catalyst for curing, contains no solvent. Said to have remarkable rapid set time and strength. **No. 1326**

More than 4,500 unclassified Atomic Energy Commission research reports are listed in the government's semi-annual price list now available. **No. 1327**

A new wire enamel and a new insulating varnish can be combined in electrical systems to withstand hot spot temperatures of 180 C. At the same time, they can be applied and cured at conventional temperatures of about 150 C. Both are polyester-type materials. **No. 1328**

Methallyl alcohol (2-methyl-2-propene-1-ol) can now be obtained in research quantities. It acts as intermediate for methallyl derivatives, can take part in polymerizations. Suggested uses: synthesis of adhesives, resins, rubber. **No. 1329**

Properties of heat resistant, cast high alloys have been compiled in a set of 14 data sheets. Information is complete, up-to-date, includes room- and high-temperature properties, uses, design and fabrication features, structure. **No. 1330**

PRODUCTS OF U.S.I.

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PETROTHENE® 200 Series — high quality resins for extrusion, injection and compression molding, film extrusion, paper coating, blow molding.

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PETROTHENE 560 Series — black, compounded resins for pipe and mulch-film extrusion.

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Pharmaceutical Products: DL-Methionine, N-Acetyl-DL-Methionine, Urethan USP, Riboflavin USP, Intermediates.

Heavy Chemicals: Anhydrous Ammonia, Ammonium Nitrate, Nitric Acid, Nitrogen Fertilizer Solutions, Phosphatic Fertilizer Solution, Sulfuric Acid, Caustic Soda, Chlorine, Metallic Sodium, Sodium Peroxide, Sodium Sulfite, Sodium Sulfate.

Reactive Metals, Oxides and Salts: Zirconium, Zirconium Oxide, Zirconium Tetrachloride, Titanium, Hafnium, Hafnium Oxide, Hafnium Tetrachloride.

Development Chemicals: Ethylaluminum Sesquichloride, Methylaluminum Sesquichloride, Monomethyl Hydrazine, Triethyl Aluminum, Trimethyl Aluminum, Unsymmetrical Dimethyl Hydrazine.

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letters to the editor

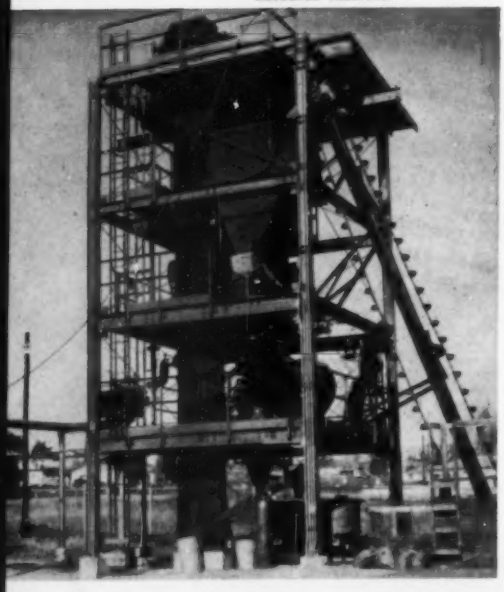
why there should be an
OIL SHALE FOUNDATION

The recent Middle East petroleum crisis has focused increased attention on the vast oil-shale deposits of the western United States. The 1,500 billion barrels of proven oil-shale resources in Colorado, Utah, and Wyoming offer a substantial alternate source of petroleum fuels, relatively free from enemy attack, in event of national emergency.

Status of Technology

During the past ten years considerable research effort has been devoted by both government and industry to the technology involved in the processing of oil shale to produce liquid fuels. Commendable strides have been accomplished in mining, in improved design of the conventional vertical retort, and in refining techniques for the shale oil obtained by pyrolysis. By comparison, however, little has been accomplished in advancing knowledge of (a) the nature of the organic matter itself, (b) its chemical constitution and relationship to the inorganic matter present, and (c) the mechanism of its decomposition under the action of heat. It is not surprising then to find that only a minimum of new processing techniques have resulted from the last decade of research.

Aspen Oil Shale Pilot Plant of Denver Research Institute.



The estimated cost of manufacturing gasoline from oil shale is now only a cent or two per gallon greater than from petroleum. It is obvious, however, that substantial further progress in retorting and refining technology will be required to reduce such costs to the point where they permit a net return on investment great enough to attract incentive capital. Such technological advances can best be assured by the accumulation of sufficient new knowledge of the fundamental nature of oil shale to provide a basis for improved process design.

The Denver Research Institute has long felt that the growing interest in oil shale has warranted a concerted effort to answer these major fundamental problems. The present Middle East situation has emphasized the urgency of research, both in the interest of national defense, and as a long-range aid to the development of a new process industry.

Because the future initiation of an active shale industry is economically still somewhat indeterminate, it has appeared that the high cost of such a research program could best be underwritten by a cooperative industry-supported project of the proper size and duration. It is obvious that the results of such a program can substantially hasten the technological advances still required.

The Oil-Shale Foundation

In an attempt to stimulate interest in basic research on oil shale, the Denver Research Institute, University of Denver, hereby announces plans for the formation of the Oil Shale Foundation, a cooperative, nonprofit program sponsored by industry and devoted to fundamental research on oil shale and its derivatives.

A three-year program of research is proposed, supported by individual industrial grants of $15,000 per year per company. It is anticipated that at least seven participating grantees can be obtained, thus providing a minimum of $105,000/year for a guaranteed period of three years.

The following abstract gives the salient features of the Foundation:

(*Continued on page* 46)

Forgive Us Our Income Tax?

Engineers and scientists should be granted a $10,000 income tax exemption.

The advent of Sputnik has inspired our political representatives to suggest all manner of means to correct the failure of the American system to produce sufficient engineers and scientists. Most of these proposals have involved rearrangement of the Defense Department, creation of additional educational facilities, granting of scholarships, and direct subsidization of promising students.

If a shortage of scientific personnel exists, it is because sufficient incentive from the standpoint of money and prestige is absent. Some means must be found to make an engineer or scientist something more than an "egg-head" in the popular mind. His income must be more than that of a bricklayer or milk-wagon driver if overriding financial attraction is to exist.

In order to provide sufficient financial attraction and recognition of the special value of engineers and scientists in the preservation of America, it is suggested that all such be given a $10,000 income tax exemption by the Federal Government. Determining who are scientists and engineers could rest in the hands of the various professional societies. As an example, all "Members" of A.I.Ch.E. would qualify.

It is suggested that the American Institute of Chemical Engineers take the lead in forming a coalition of other technical and scientific societies of professional stature to approach the appropriate congressional committees. The societies would be doing a public service both for the country and their members in promoting such legislation.

A tax exemption would provide official recognition of the professional status of engineers and scientists and it would do much to prevent migration of teachers in scientific schools into industry. It would make no dislocation of present salary structures within industry, and such efforts by the professional groups would convince members that their society was genuinely interested in improving their professional standing and income in a more practical way than any Union ever could.

R. A. Clarke

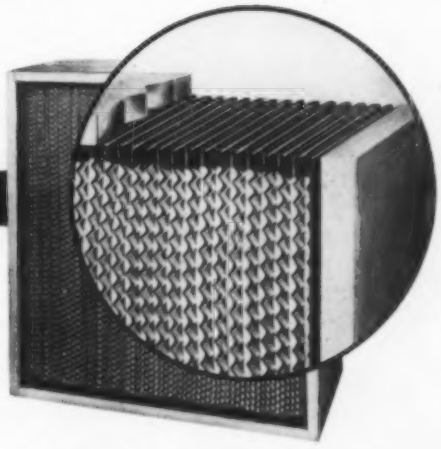
Flossmoor, Illinois

A Specific Cambridge Filter for Each Specific Requirement in Tracerlab's New Building

The new Waltham, Mass. plant of Tracerlab, Inc., pioneers in isotopes, nucleonics and X-ray, will be the most modern nuclear instrument plant in the world and will contain the world's largest commercial radiochemical facilities. For safety and product quality, a wide range of air filter efficiencies are required. Only Cambridge was able to supply the right filters for each requirement.

For Removing Radioactive Particles...

Cambridge ABSOLUTE Filters safely remove all hazardous particles from radiochemical areas in the new Tracerlab plant. Absolute filters, specifically developed for the A.E.C., have been used for many years in the removal of radioactive particles. Each filter provides a guaranteed efficiency of 99.95% on particles of 0.3 micron (.0000118") diameter.



Cambridge ABSOLUTE® Filter

Cambridge AEROSOLVE® Filter

...For Clean Air in Non-Radioactive Areas

Cambridge AEROSOLVE 85 filters are used in critical manufacturing and assembly areas. AEROSOLVE 35 filters are used in other manufacturing and office areas.

Aerosolve Filters cover quality comfort air cleaning as well as a wide range of critical industrial requirements. Filter efficiencies from 35% to 95%* are available. These filters remove both visible and invisible (below 10 microns) smudge-producing particles.

**Based on the National Bureau of Standards (N.B.S.) Discoloration Test on Atmospheric Dust.*

Cambridge filters cost less than any other filter of comparable efficiency. Write for complete information.

CAMBRIDGE FILTER CORP.

Pioneers in High-Efficiency Air Cleaning

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Representatives in Principal Cities

Let George do it...

...but when it comes to vacuum

LET GRAHAM DO IT

We have developed the Graham Steam Jet Ejector to a degree of perfection that provides industry with an economical and reliable source of vacuum at low first cost.

You cannot afford to overlook the possibilities of a Graham Steam Jet Ejector—our recent developments have permitted us to really "gild the lily". And the Graham laboratory at Batavia, New York is constantly exploring new fields of vacuum application.

Graham sales engineers are located in the following cities. You are invited to consult them without obligation.

Baltimore, Md.	Detroit, Mich.	Philadelphia, Pa.
Birmingham, Ala.	Hato Rey, Puerto Rico	Pittsburgh, Pa.
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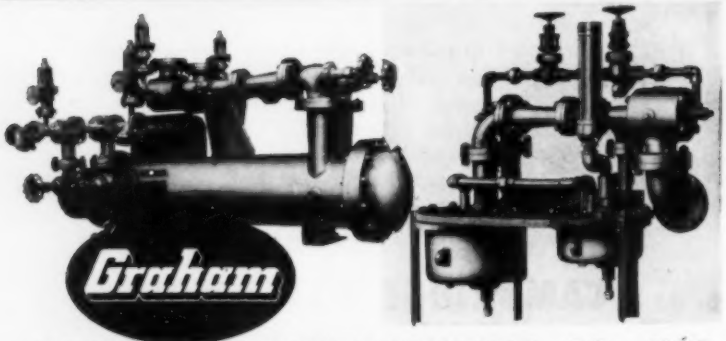
Cincinnati, O.	Los Angeles, Calif.	Seattle, Wash.
Cleveland, O.	Mexico D.F., Mexico	St. Louis, Mo.
Coral Gables, Fla.	Minneapolis, Minn.	Toronto, Ont.
Denver, Colo.	Mobile, Ala.	Tulsa, Okla.



GRAHAM MANUFACTURING CO., INC.

415 LEXINGTON AVENUE, NEW YORK 17, N. Y.

Letters to the editor

OIL SHALE FOUNDATION

(*Continued from page* 44)

- The Oil Shale Foundation is to be established for the sole purpose of conducting *basic and fundamental research* on oil shale and its derivatives. Developmental and *applied* research, which has as its objective the design of commercially useful products and processes, is not considered to be part of its efforts.
- Since the University is a nonprofit institution, the Foundation is also nonprofit, and funds contributed by each sponsor may hence, at his discretion, be partially tax deductible.
- Each participating sponsor shall appoint one representative to a Technical Advisory Committee for the Foundation. This Committee shall meet semiannually to review the progress of the research, consult on the future direction of the program, approve research results for publication, and to be advised on any patentable discoveries accruing.
- The research results are to be disclosed to the participating sponsors through the medium of semiannual reports. These results are to be reviewed by the Technical Advisory Committee, which may release them for publication in appropriate technical journals at proper intervals.
- Although patentable discoveries are not deemed likely from a program of fundamental research of the type proposed, such patents as may issue from the Foundation's efforts are to be assigned to the University of Denver. The University, in turn, shall grant a nonexclusive, royalty-free license thereto to each participating sponsor. Nonsponsors shall be entitled to a royalty-bearing license under such patents, at the discretion of the University.

A prospectus setting forth details of the proposed research program and the accompanying agreement to be entered into by each participant has been mailed to prospective industrial organizations. Interested companies may secure further information by addressing Dr. Charles H. Prien, Denver Research Institute, University of Denver, Denver 10, Colorado.

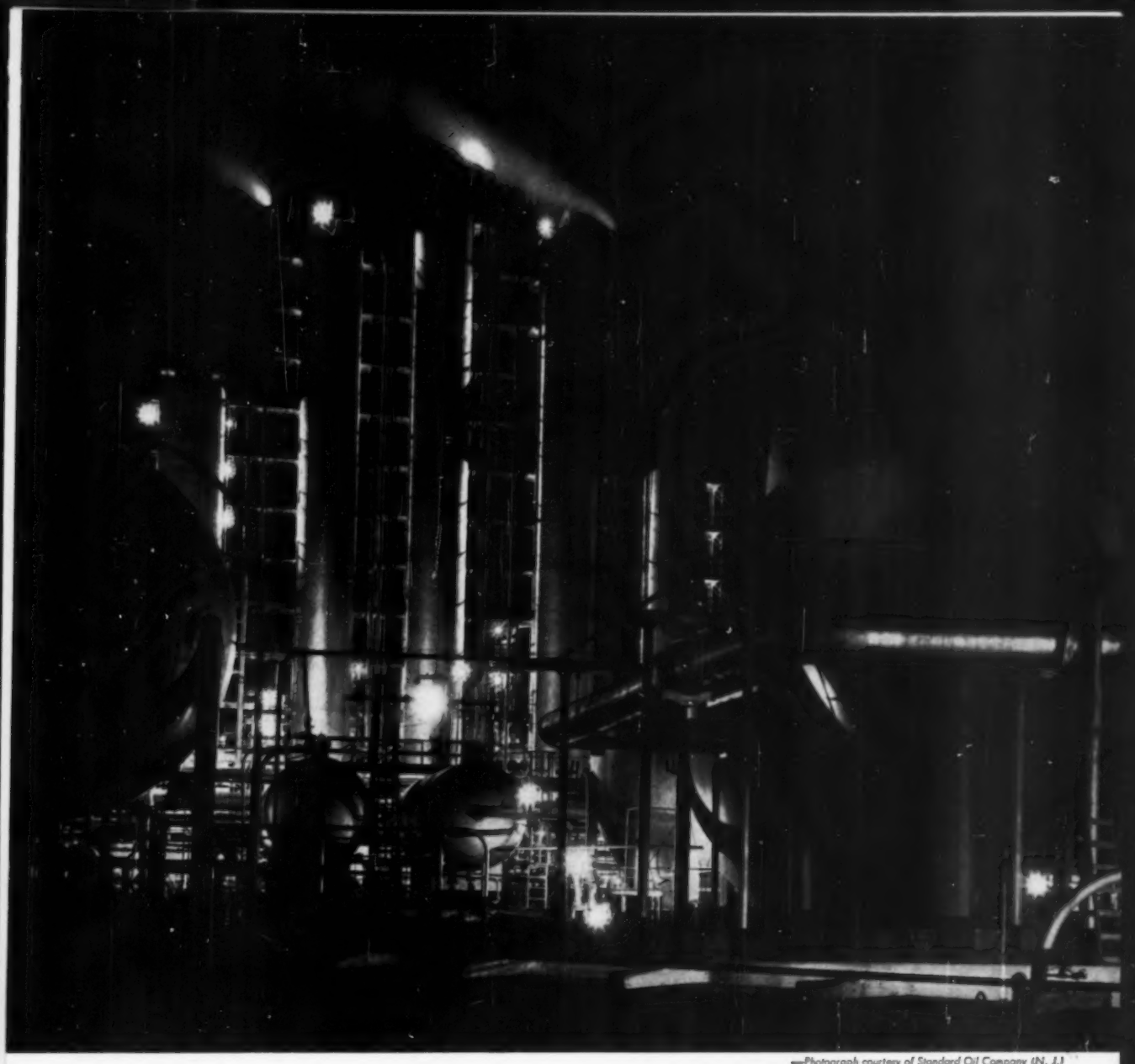
Charles H. Prien
Head, Chemistry & Chemical Engineering Division
Denver Research Institute
Denver, Colorado

Render Unto Girdler

On page 116 of the November 1957 issue of *CEP*, the second item in the middle column indicates that the Henry Vogt Machine Company of Louisville would have on display [at the New York Chem Show] a "Votator continuous thermal processor for viscous fluids."

Naturally this came as quite a surprise to the representatives of our Girdler Company, who are rightly positive and justly proud of the fact that no one except the Girdler Com-

(*Continued on page* 48)



—Photograph courtesy of Standard Oil Company (N. J.)

How much can preheat raise throughput?

Today's soaring production costs spotlight the need for increasing throughput . . . that is, if slim profit margins are to be kept from disappearing altogether. A look at the Ljungstrom Air Preheater will show how this can be done.

Ljungstrom efficiency comes from the fact that preheated air mixes more thoroughly with fuel. This assures more complete combustion . . . higher flame temperature . . . and increased heat absorption into the tubes – which raises still throughput by as much as 25%!

For example, an eastern refinery went from 16,000 barrels to 18/20,000 barrels a day when the pipe still was modernized with a Ljungstrom system. In addition, temperature control was much closer. The octane rating of the product, because of this fine control, was held to narrower limits – *with the average rating as much as two octane numbers higher.*

How fast is "WRITE OFF"?

In earnings from increased output and improved quality, many refineries write off the cost of the Ljungstrom in less than 2 years. These costs can be written off sooner, in fact, when you add other Ljungstrom advantages: savings up to 20% in fuel costs . . . higher throughput . . . less slag . . . and use of fuels you used to discard.

For more complete data on what the Ljungstrom Air Preheater can do for you . . . for an analysis of the heat recovery benefits obtainable in fuel burning equipment – call or write the Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

letters to the editor

MORE ON THE REPROCESSING PACKAGE

In suggesting that industry consider the possibilities of small chemical processing plants [see *CEP*, January, 1958, page 122], I knew that there would be many who disagreed with the thought. It is doubly interesting, therefore, that in the last several months about a dozen companies have expressed interest. In fact the number of inquiries is growing.

The basic facts remain unchanged. If industry is to accept its usual responsibility for handling its own needs and process irradiated fuel from privately owned reactors, attention must be given to the engineering of small processing plants. The presently foreseeable market through 1965 just won't support a large plant or one designed to handle a variety of reactor-fuel types. Yet irradiated fuel from industry-owned nuclear power plants will be discharged from reactors, possibly as early as 1960-61.

It would be unique indeed if small fuel reprocessing plants could compete with the unit costs obtainable at a large plant. However, that is not the problem as I see it. The problem is how to arrive at the lowest cost method of handling the quantities of irradiated fuel to be discharged during the next few years before nuclear power plants are installed in large numbers. In this connection it is interesting to note that twelve countries, members of the Organization for European Economic Cooperation, have agreed to set up an international company to construct and operate a small plant for the chemical processing of irradiated fuel materials. They, too, are faced with the problem of servicing the growing nuclear power capacity in their countries prior to a full-blown nuclear power economy. The initial plant will have a capacity of about 100 tons of natural or slightly enriched uranium a year. The plant is expected to handle a variety of fuel types and will include considerable research facilities. The estimated construction cost is $12,000,000. The plant would be considerably larger and more versatile than a plant designed to handle fuel from a single reactor on a production basis.

On the domestic scene, the AEC has stated a willingness to process spent fuel for industry and has published the basis for the charges it would make. This step was considered necessary to assure those building reactors that such an important problem would not be left up to them and to allow them to make firm economic calculations in this field. However, the AEC action does not pretend to solve the whole problem. A panel of qualified industrial personnel recently reported on fuel cycle costs to the New York Chapter of the American Nuclear Society. It had this to say:

". . . the hypothetical plant upon which the (AEC) charges are based is a highly subsidized operation. . . . To arrive at a realistic reprocessing charge, one must consider a privately owned and operated plant."

While a small plant will not give the ultimate answer to fuel reprocessing costs, it will give true costs in the present state of the market. If advantage is taken of design savings by having the plant handle a single type of fuel on a production rather than a research basis, the total capital and operating costs can be held to a minimum. Operation of the plant should take advantage of all sources of revenue, including the processing charge, the sale of recovered radioisotopes, and even the processing of "cold" uranium scrap in otherwise idle time.

I might add that sales of radioisotopes by the AEC last year reached $2,700,000, about 22 per cent above 1956 sales. The small chemical processing plant can be an important source of supply for the fast-growing radioisotope market. Recovery of at least some radioisotopes should not be overlooked in designing a processing plant.

No one can say with certainty that revenues are likely to exceed costs at such a plant. This cannot be known until designers come forth with the necessary economic and technical feasibility studies based on a conceptual design. Such a design, to have the greatest value, should be based on the needs of one of the large power reactors now being built by utilities. This is true particularly if the chemical plant is designed for location at a reactor site to maximize savings. Whether the utility or a chemical company should own such a plant is moot. It seems to me that chemical companies having actual power reactor fuel processing experience will be in the strongest position to grow with the market. Probably they could consider a small plant as part of their development effort. Certainly the experience and the market position to be gained would be at a minimum of expense.

To sum up, utilities need to know the industrial cost of spent fuel processing, chemical companies would find it useful to have experience with a small plant before building a large one, independent engineering firms need customers to pay for engineering a plant. (AEC has not engineered such a plant.) All three have a common interest in the problem. It seems to me that it won't be too long before some of these now separate groups team up to handle the problem within industry itself.

C. G. Manly
Assistant Director for
Commercial Development
U. S. Atomic Energy Commission
Washington, D. C.

The Things That Are Girdler's

(Continued from page 46)

pany is selling Votator equipment in this country.

I'm sure it was all a mistake, but if you have a simple answer, I would appreciate being able to pass it on to the folks in Louisville.

Gene Wedereit
National Cylinder Gas Company
Chicago, Illinois

Pardon our blushes. We know better, but the printer doesn't. Ed.

The "Not" That Failed

It was indeed a pleasure to preside over the session of the symposium of the New York Section on the Legal Aspects of Knowledge on October 22. The comments of the speakers and the consensus as given in the article, "One-Day In New York" (December *CEP*, p. 102), represent good coverage. I have one exception, however: in the concluding remarks on page 106, the word "not" was omitted from a sentence, and without it there is utter confusion. My statement should read: "When engineers realize that their developments are *not* being given suitable notice, they tend not to 'sell' the advantages of their profession to others who might normally be of a mind to pursue such an occupation, thereby contributing in some respect to the current 'shortage of engineering personnel'—not so much by design as by lack of interest."

Bertel Greffrath
Bronxville, New York

News from
National Carbon Company
Division of Union Carbide Corporation · 30 East 42nd Street, New York 17, N. Y.
Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. IN CANADA: Union Carbide Canada Limited, Toronto

National Carbon representatives expand your engineering force

J. F. BRAUNING, SALES ENGINEER

Mr. Brauning graduated from M.I.T. with a M.S. in chemical engineering. Prior to joining National Carbon Company, he was active in research and development with a large chemical company in the East.

Mr. Brauning's first two years with National Carbon were spent in initiating design proposals on the basis of customer inquiries. Later he worked for two and a half years developing new designs and improving existing designs of "Karbate" chemical processing equipment. For six years Mr. Brauning was district office engineer where he assisted sales engineers on technical problems. For the past seven years he has been a field engineer representing National Carbon Company to the chemical processing and allied industries.

This calibre of training and experience qualify Mr. Brauning to assist in the selection, special designing and installing of carbon, graphite and "Karbate" chemical processing equipment. Call your National Carbon Sales Engineer today.

Low permeability graphite stock available from National Carbon

This low permeability graphite can be used in high temperature applications where greater degrees of imperviousness than obtained with ordinary graphite are required. The material is designated as Code 82 graphite and has a permeability in the range of 1-10 millidarcys. Field tests show this material is well suited for fused salt vessels, thermocouple sheaths and low pressure gas heaters such as those used in the heating of chlorine by the electrical resistance of the tube walls.

Code 82 graphite is available in tubes, cylinders and blocks. Its permeability is uniform and equipment can be machined or fabricated from the stock forms without impairing the degree of imperviousness. For more information contact National Carbon Company, P.O. Box 6087, Cleveland 1, Ohio.

"Karbate" Internal Low-Fin tube exchangers provide high corrosion resistance at prices comparable to carbon steel exchangers

The following comparison made by a National Carbon Field representative shows the relatively low cost of "Karbate" impervious graphite corrosion resistant heat exchangers using the newly developed internal low-fin tube.

The problem consisted of cooling 150,000 pounds per hour of a sulfonated hydrocarbon mixture from 300°F. to 100°F., using 85°F. water. Heat transfer wise, both "Karbate" impervious graphite and steel could be used. But corrosion wise, plain steel would not be considered for handling sulfonated hydrocarbons. Substituting more corrosion resistant austenitic and molybdenum stabilized austenitic stainless steel would jump the price of the metal unit two or three times that of the "Karbate" impervious graphite unit. All comparisons are based on units with carbon steel shells and floating end construction.

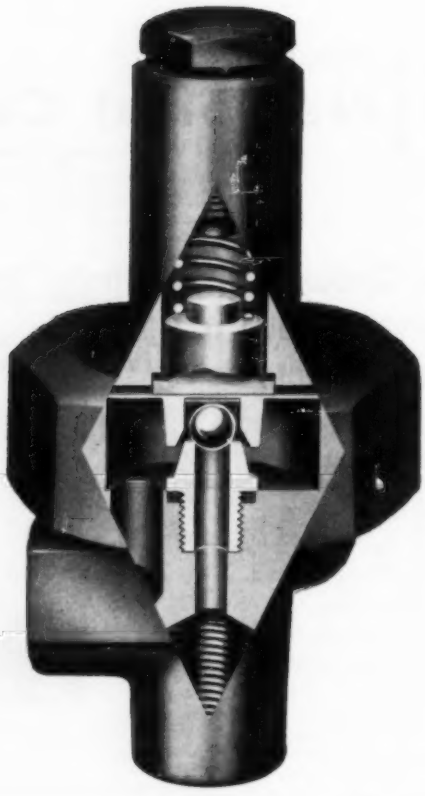
The low cost extra surface required in the low-fin design reduces the operating heat flux of the unit, and hence the temperature drop through the tube side fouling factor. This means a longer operating cycle between cleanings. Consequently, not only is the "Karbate" unit less expensive to obtain but also it is less costly to maintain.

Exchanger	Size	Area	Shell Side Pressure Drop	Tube Side Pressure Drop	Overall Coefficient	Dirt Factor	Price
"Karbate" Impervious Graphite	33" I. D. shell with 349—¾" I. D. x16 ft. long internal low-fin tubes.	3360 sq. ft. based on I. D.	13 psig	10 psig 8 pass	69.5	.003	$16,700
Steel	45" I. D. shell with 904—1" I. D. x14 BWGx16 ft. long tubes.	3780 based on O. D.	13 psig	10 psig 12 pass	62.0	.003	$13,700

NATIONAL TRADE-MARK

The terms "National", "N" and Shield Device, "Karbate" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

UNION CARBIDE



Take a second look

At a Milton Roy Chemical Relief Valve

Leakproof construction in steel, 316 stainless steel, Carpenter 20 stainless, Hastelloy "C" or "B" available from stock. Top works protected by Kel-F or Teflon diaphragms. Specify Milton Roy relief valves for pressures to 1500 psi. Sizes: ¼", ½", ¾", and 1".

Corrosion resistant back pressure valves, with Teflon diaphragms, are available for service at pressures to 200 psi.

Guard the accuracy of your Controlled Volume Pump—protect your process equipment . . . write for detailed information to Milton Roy Company, 1300 East Mermaid Lane, Philadelphia 18, Pennsylvania. Engineering representatives throughout the world.

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1. WE WILL MANUFACTURE TO YOUR DRAWINGS.
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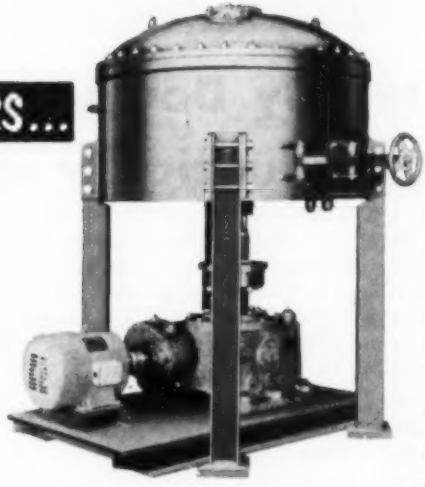
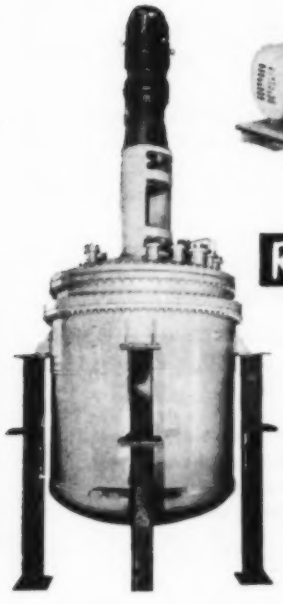
PAN DRYERS...





REACTION KETTLES

We will modify our standard designs to meet your process requirements.

We adapt successful processing schemes, heat transfer arrangements, agitation systems, and reaction setups to meet your processing needs. Our designers will also draw upon our proven mechanical elements—bearings, drives, and stuffing boxes, for example—for your equipment. We will pass on the results and savings in pattern and design cost to you.

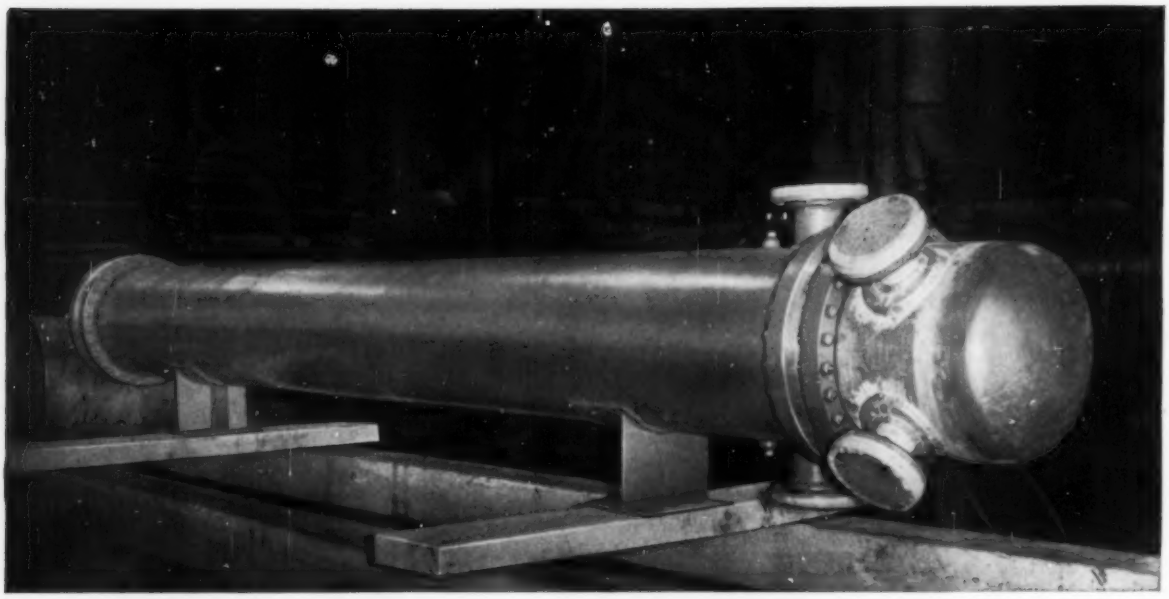
The pan dryer at the left is an example of such design adaption. It's made of ELC Stainless Steel and stress relieved. Again the reaction kettle, which is a steel jacketed cast iron vessel, illustrates the adaptation of standard packing glands, cantilevered shaft, and agitation.

In like manner, we offer various types of cast iron, stainless clad, and Thermocoil kettles for reaction, agitation, heat transfer, distillation, sublimation, crystallization, and drying.

For further details, write to have a Bethlehem sales engineer call—no obligation.

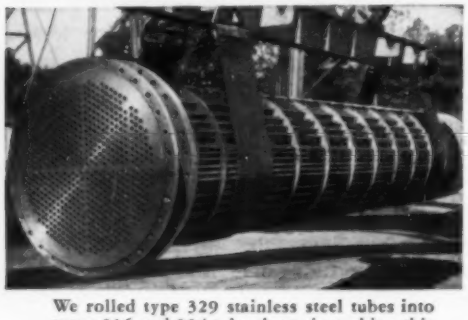
BETHLEHEM FOUNDRY & MACHINE CO.

Process Equipment Division **Bethlehem, Pennsylvania**



Aluminum translated by Downingtown... metallurgically speaking

Putting the finishing touch on another heat exchanger unit built by Downingtown.



We rolled type 329 stainless steel tubes into types 316 and 304 tube sheets in making this stainless steel replacement bundle.

The special problems of aluminum welding and fabrication are another metallurgical "language" that has been expertly mastered at Downingtown. In this fixed-tube sheet heat exchanger unit, aluminum heads, tubes and tube sheets have been combined with a carbon steel shell to meet specific service conditions.

When heat transfer specifications call for aluminum...or aluminum bronze, nickel, copper, stainless steel, or almost any clad or alloy... you'll find the metallurgical idiosyncrasies are well understood at Downingtown. Send for our informative booklet on heat exchanger design.

SPECIFICATIONS OF THE UNIT

Materials: Aluminum Tube Side and Carbon Steel Shell
Tubes: 192 Alclad Tubes, ¾" O.D. x 16 ga. x 14'0" L
Shell Diameter: 18"
Over-All Length: 16' 1"
Design Pressure: Shell Side, 100 psi—Tube Side, 200 psi
Test Pressure: Shell Side, 150 psi—Tube Side, 300 psi
Design Temperature: Shell Side, 250° F.—Tube Side, 350° F.
Code Stamped: Inspected by Purchaser and Hartford

Downingtown Iron Works, Inc.

106 Wallace Ave., Downingtown, Pennsylvania
division of PRESSED STEEL TANK COMPANY Milwaukee
Branch offices in principal cities

HEAT EXCHANGERS—STEEL AND ALLOY PLATE FABRICATION
CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

UNDIMMED CONFIDENCE

Although the chemical industry is looking forward with some apprehension to the first half of this year, its confidence in the long-range future remains undimmed. Leading companies are continuing to spend enormous sums for expansion to cover expected big markets in 1959 and 1960. Much of this money is going into plastics facilities and raw materials for plastics—especially some of the newer materials such as polypropylene.

However, chemical sales suffered the sharpest slump in many months in December and there was little important improvement in January. Opinions in the industry differ as to how soon a real recovery will occur.

Now that the government has taken steps to ease money rates and relieve the tight money situation it would seem that a business recovery will be only a matter of time. The feeling in financial circles is that, in view of the cold war with Russia and the additional threat of economic warfare, the United States simply cannot afford a depression and that the most drastic measures will therefore be taken by the government to bolster business.

Nonetheless, the easing of money rates and increases in defense expenditures will not necessarily bring about an immediate business upturn. It may well take months before the impact is felt. Chemical people point out, for example, that at the end of the year they were feeling cuts in defense expenditures for some of the new metals—cuts that were made months ago. So the effects of increased expenditures will also take time to be reflected.

Continuing Chemical Optimism

But, looking further ahead, there is no question of the optimism of chemical executives. Union Carbide, for example, expects to spend $180 million for new plants in 1958 on top of a similar expenditure in 1957. Dow Chemical will have spent around $200 million by the end of its May, 1958, fiscal year but such spending may taper off in the last half of this year. American Cyanamid spent $75 million on plants in 1957 and has a large budget for 1958.

A recent survey by the Manufacturing Chemists Association showed that chemical industry in the three-year period 1957-1959 has budgeted plant expenditures of $3,840 million, of which $1,300 million were completed in 1957. Of the total, $864 million goes to new construction in Texas and $494 million in Louisiana, much of this obviously for petrochemical facilities. New facilities for plastics will account for about $450 million.

New Plastics, New Markets

The production of all plastics reached a new high of about 4,387 million pounds in 1957 against output of 4,124 million pounds in 1956. Dollar volume ran over $2 billion. Biggest selling materials last year were vinyls, with a volume of 841 million pounds (up 11 per cent from the preceding year) and polyethylene, with a volume of 682 million pounds (up 22 per cent). Polystyrene held firm at around 635 million pounds.

Based on the capacity of plants now planned or being built, output of high pressure polyethylene should be around one billion pounds a year by 1960, while capacity for low pressure, or high density polyethylene should by then be around 430 million pounds. Although a number of firms have gone into the production of the high density polyethylene, reports from the plastics industry indicate that there have been difficulties in educating fabricators in the use of the new material which requires somewhat different techniques. It may thus be inferred that some of the new plant capacity may be slow in bringing in substantial earnings.

Polypropylene plastics, chemical cousins of the polyethylenes, have a number of desirable properties which are expected to give them a large and growing market. First important producer in this field is Hercules Powder, operating under Ziegler patents.

There are several other areas where much development work is being done and where long-term growth in sales and earnings is looked for. Plastics people are hopefully estimating a 20 per cent gain in the sale of reinforced plastics this year on top of a similar gain made in 1957. Important consuming fields are in missiles and aircraft, in home and commercial construction, and in consumer goods and electrical equipment.

Important new markets are also looked for in the urethane resins in addition to their well-known uses in foams for upholstery. Enthusiasts believe that these materials will prove to be better than epoxy resins in paints and coatings with uses ranging from coatings over glass laminates to highway markings on roads. They have worked out well as marine paints on boats and ships and make excellent adhesives. Development work indicates the feasibility of making wall panels of rigid foam between plywood layers and of spraying foam which solidifies on the interior of freight cars or of buildings for insulation. There is also much interest in the use of the material in long-wearing automobile tires.

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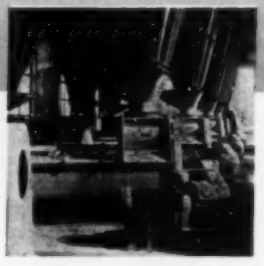

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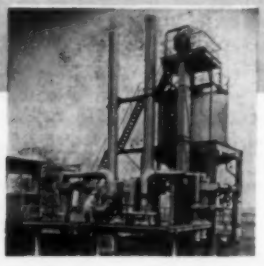

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A KEY TO THE STORAGE TANKS

A recent proposal* by Charles G. Manly of the AEC that private industry might well add significant credits to its anticipated earnings from fuel reprocessing through the manufacture and marketing of radioisotopes is intriguing. Manly's proposal hinges on the reactor fuel to come from utility and other reactors being built or scheduled. To be successful, the plan would depend upon industry's ability to develop a market for the isotopes.

In order to do this, industry should presumably get into the isotope business as quickly as possible, learning how to make and handle these "hot" products and how their customers can make use of them. Limiting this activity to isotopes derived from reactor fuel yet to be produced would seem to impose unnecessary delay and expense. This would arise from the need to 1) determine the optimum fuel reprocessing facility (which the AEC is preparing to undertake at low cost), and 2) to provide the considerably larger outlay of capital needed for fuel reprocessing.

But, if isotope making and marketing is a good idea, why shouldn't industry start now, using as raw materials the stored fission product solutions from the government reprocessing operations (as described in the Manowitz "brief" on page 91 of this issue)? This would offer the advantage of lower capital investment, and would eliminate the need to decide now upon optimum fuel reprocessing plant design, etc.

Thousands of gallons of these isotope-rich solutions lie in expensive storage facilities—clearly a burden upon the technologists who must maintain them against leakage, and upon the taxpayers who must carry the financial load.

For U. S. private industry to get underway in the use of these waste solutions (and, for that matter, portions of the fresh streams added continually), it is essential that the Commission make available all the pertinent chemical properties of the various lots of stored solutions (presently understood to be classified), including the anticipated product decay rates and emphasizing the p.p.m.'s of important isotopes. In addition, in order to make this information of maximum value for the design of production plant facilities and the laying of marketing plans, a definite number of gallons for each lot analyzed should be indicated as "available to industry for processing" —it being understood that such figures would bear no relationship either to the total quantities of these materials in storage or to the rates of addition to that storage, since they would touch upon the sensitive area of weapons production rates.

Surely, the release of such information will go far toward accomplishing what today so many of us want to see—renewed interest and activity on the part of the chemical industry in our nation's nuclear future. J.B.M.

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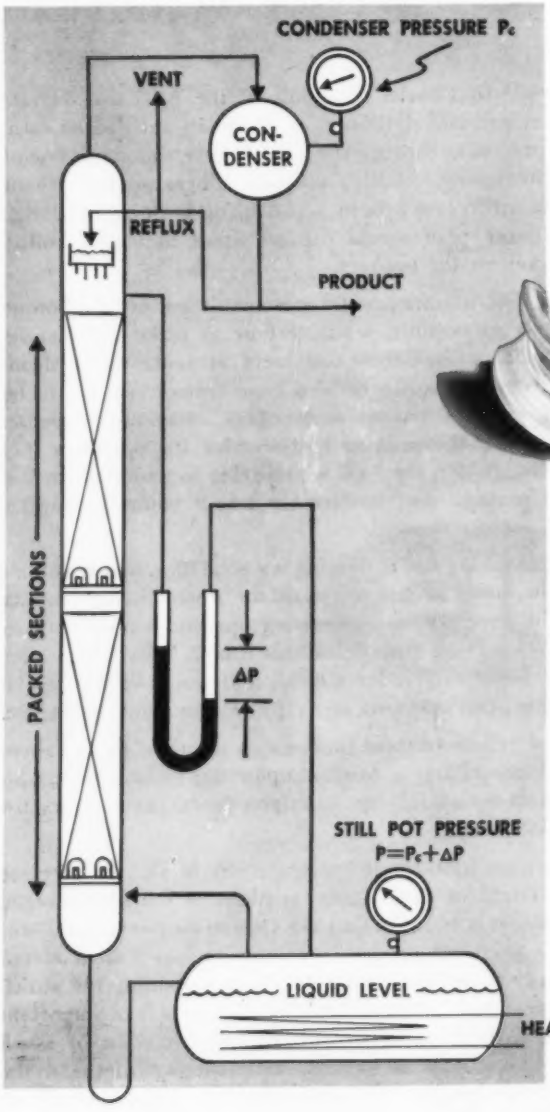
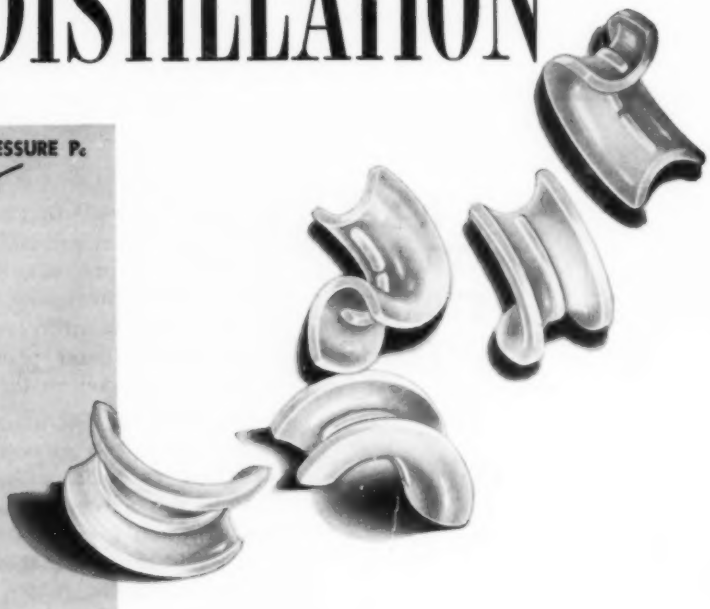
* See *CEP*, January 1958, page 122, and this issue, page 48.

How to Lower Pot Temperatures in

VACUUM DISTILLATION





One of the important aims in vacuum distillation is to maintain as low an operating temperature as possible. High temperatures are injurious to many organic materials. Particularly, in batch operations, where virtually all the heat must be supplied to the liquid in the pot, losses due to pyrolysis can be substantial.

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the impact of

nuclear energy

on the chemical process industries

time for more data, fewer prophecies

Raymond E. Vener | Catalytic Construction Company, Philadelphia, Pennsylvania

Over the past dozen years there has been a steady flow of predictions and speculations on revolutionary changes in industrial operations that can be expected from atomic energy developments. Rash exaggerations and claims, motivated by political, promotional, advertising, and other factors obscure the true potential of many atomic energy applications and activities. Frequent excesses of enthusiasm and optimism have engendered considerable skepticism in some quarters. It is quite difficult to segregate fact from fantasy in many recent publications and speeches. While many of the more serious estimates are sound, a vast number can be classified as nonsense. We have reached a time when we need more data and fewer prophecies.

The current $2 billion a year expenditure of the Atomic Energy Commission indicates the dominant role of the government in atomic energy, particularly in comparison with the amount spent by private industry. This has contributed to the common misconception of an "atomic energy industry," separate and distinct from chemical, metallurgical, and petroleum activities.

With increasing participation by private enterprise, the industrial access programs, declassification of information, redefined patent regulations, and somewhat more attractive commercial incentives, the AEC monopoly on atomic energy activities has been supplanted by a so-called government-industry liaison. Progress has been made, but it is now clear that industry must take more responsibility in delineating the future role of government in all aspects of atomic energy, but especially commercial applications. We are lagging in the industrial development of atomic power primarily because American private industry does not have an adequate economic incentive to assume the costly job itself.

Obviously, we will continue to lag if the government does not finance the research and development, pilot plant and plant-scale operations which industry is not ready to shoulder.

Congress is presently reevaluating the status and goals of our atomic energy program. Following the Sputniks, political considerations in atomic energy activities are extremely important. International implications of the forthcoming Geneva conference on atomic energy scheduled for this summer will be far more critical than in the 1955 conference. There is every indication that all possible propaganda devices will be utilized by many nations. Without question, these international conferences on atomic energy have been the largest single factor in the pressure to declassify much of the data compiled in United States atomic energy programs over the past fifteen years.

Those familiar with atomic energy programs in the United States will agree that we have no reason for complacency. In normal industrial practice, processing techniques are constantly changing to meet competition. The industrial philosophy of constant, objective review and willingness to re-

vamp or even scrap entire plants when processes are obsolete is gradually being adopted in atomic energy operations. For instance, many of the operations used for processing of ores to concentrates, subsequent refining of these concentrates to UF_6 or uranium metal, and reprocessing of spent fuel and waste disposal were to a large extent frozen for approximately a decade. Over the past several years there have been intensive programs directed at optimizing these operations.

We now urgently require a positive and definitive exposition by the government of the short- and long-term objectives of our nuclear program, along with a specific definition of what constitutes our national interest. These must be devoid of the customary trimmings, prophecies, and pressures. Once we have a well-defined and logical policy that we can all get behind, we will be in a better position to get on with the task of implementing the President's Atoms-For-Peace Program.

Frank use of the word "subsidy" would resolve many of our difficulties. The type of subsidy pattern, such as will be required to expedite the United States atomic energy program, would not differ greatly from that employed in expediting and implementing the development of aircraft technology.

It will become increasingly more important to appreciate fully that no clear demarcation or distinction can be established among: domestic and international aspects of AEC programs; military versus peacetime projects; scientific versus political considerations; and private versus public power.

Contrary to all the current reports, there is nothing novel about the present situation except the degree. This applies equally to such questions as: What will our new policy be? How will it be implemented and administered, and what will be the time schedule to meet foreign policy objectives? How much additional government subsidy is justified? What form should it take and who should get it?

If there is a single word to identify the problems surrounding all atomic energy programs, it is *time*. This applies equally to: public versus private power; domestic versus foreign programs; power reactors; nonpower reactors; fusion versus fission; degree of private participation in AEC operations versus government subsidies, classification; technical personnel; health hazards; insurance; and various nonpower applications. Whenever you press the time schedule of a research and development program beyond all reasonable limits, you are obviously in a crash area—normal, logical, systematic research and development philosophies no longer apply.

Review

At present, the preponderance of AEC expenditures and activities is still geared to military demands. Indeed, it is quite impossible to establish any clear demarcation between military and nonmilitary programs.

Process technology and chemical and equipment requirements are still in a state of flux. There is now a great deal of commercial interest in processing ores directly to a highly purified product—UO_3, UF_4, UF_6, or metal.

The three government-owned refineries for converting concentrates to metal (at St. Louis and Weldon Spring, Missouri; and at Fernald, Ohio) all employ different solvent-extraction systems. In the recent bidding for the first privately owned refinery, most of the seven groups submitting bids utilized processes radically different from those at any of the AEC facilities. The new routes would obviously have involved different chemicals, supplies, and equipment. It is certain that present technology and processes in this area are far from optimum. It is also interesting to note that overtures to the government have been reported relative to possible purchase by private industry of AEC-owned uranium refineries. Indicative of the confused situation is the fact that the St. Louis refinery operated by Mallinckrodt for the AEC will be shut down this year once the Weldon Spring plant is on stream.

Recent limitations by the AEC of domestic uranium production and of foreign purchases have apparently caused some dismay in uranium mining and milling circles, even though the announcements were not unexpected. Based on the rapid and often abrupt developments in uranium operations over the past dozen years, I believe a sharp upturn in government, private, and foreign requirements will be inevitable, possibly over the next decade and certainly over the next twenty years.

While nuclear reactors, fuel fabrication and fuel reprocessing have been demonstrated to be technically feasible, the over-all economics have definitely not been established. We still do not have a process that is even technically feasible for permanent radioactive waste disposal.

Technology

With regard to scientific data and process information from atomic energy operations, there remain the formidable problems of security restrictions, organization of technology, and the equitable and efficient dissemination of information. Private industry is insisting on access to all government or AEC data, within the confines of realistic defense regulations, to permit sound judgments on business or research ventures. Considerable progress has been made on declassification and access programs over the past two years. However, those familiar with various AEC programs and reports realize that total numbers of reports, as such, are meaningless. Many are random and inconclusive progress reports; others represent obsolete data and technology which can be quite misleading.

There is an obvious tendency by book publishers, technical societies, and engineering and scientific journals to treat all activities relating to atomic energy as a new technology or science. In many instances the relationship to radiation or nuclear phenomena is vague. As more unclassified information is made available, it becomes increasingly important that the vast majority of it be absorbed in appropriate publications and abstracts already in existence.

It is obvious that "state of the art" philosophies still underlie most publications on atomic energy. This is precisely the type of "processing technology" concept that has, in the past, seriously isolated and complicated interchange of ideas, data, and technology among the process industries' fields, employing the duplicable operations and processing steps common to the pharmaceutical, petroleum, petrochemical, extractive metallurgical, pulp and paper, plastics, and other fields. In place of this "state of art" or technique concept of atomic energy, we should substitute, wherever possible, the most advanced methods of digesting, evaluating, correlating, and publishing data in established journals and book series, and we should do this through existing technical societies.

Tonnage quantities of technical miscellanea, from all stages of progress on innumerable atomic energy projects, are being declassified and released without comprehensive critical review. This is causing confusion as to the actual state of know-how in the field. A standard literature search of classified and unclassified data is not only difficult—it is virtually impossible.

One of the most serious problems encountered in utilization of libraries and filing systems which segregate information in terms of both subject matter and degree of classification has been the frustrating difficulty of pursuing anything resembling a conventional literature search. The AEC has worked persistently to expedite

and systematize availability of classified material. Still, the obstacles have been time-consuming, costly, and most certainly have been a grave deterrent to private investment. No competent technical organization expects or can accept guarantees from a government agency that all the information it will need or may encounter through subsequent data reorganization, declassification, or downgrading is already available in a certain category.

Technical Personnel

Requirements for engineers by industries related directly or indirectly to atomic energy can be grouped into two categories:

- **The engineers in all the familiar categories: chemical, mechanical, civil, metallurgical, electrical, etc. Depending upon the particular field of work, some degree of familiarity with radiation technology may be required.**
- **Engineers with a very strong background of nuclear physics for reactor design. These would be specialists who might be originally trained in atomic physics with subsequent engineering training, or vice versa.**

Since World War II there have been many surveys, predictions, and auguries by government officials, industrial representatives, and university spokesmen concerning the anticipated critical shortage of nuclear engineers, in particular, and all types of engineers and scientists, in general, over the next decade. There has always been considerable doubt as to the validity of many of these predictions and opinions.

It appears unrealistic to attempt, by any simple formula or routine questionnaire distributed to actual or potential contractors, operators, etc., to arrive at any conclusive estimate of future needs. There are so many complex variables and intangibles, political developments, government decisions, and rapid scientific changes, that it is mandatory to view with skepticism flat statements and predictions on future manpower requirements.

One of the most remarkable fantasies evolved in fields related to nuclear energy is the familiar cliché that physicists have been and are the predominant factor throughout all areas of nuclear energy. Nothing could be further from the truth. Fundamental scientific developments based on work of physicists as well as chemists have been and will continue to be vitally important in nuclear energy. However, the majority of technical manpower required for such diverse activities as engineering, hardware production, construction, instrumentation, operation, etc., are essentially the familiar professional categories (chemical, mechanical, metallurgical, civil, electrical, etc.).

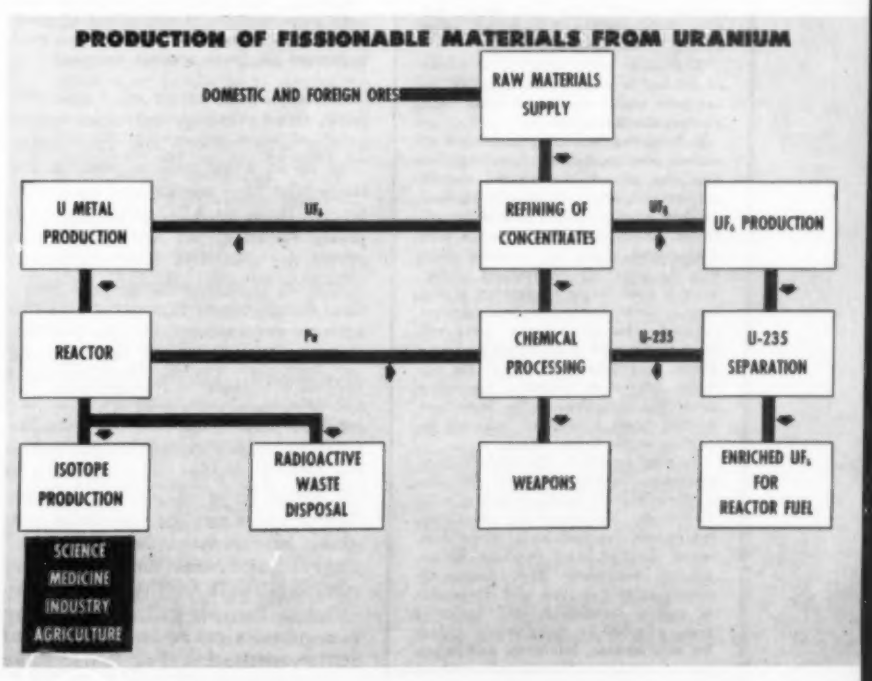
While hardly revolutionary and awesome in its impact on the lives of everyone, a rough analogy can be made to the effect of catalysis on the chemical, and particularly the petroleum, industries over the past two decades. The engineers and scientists were required to become conversant with catalytic phenomena, on bases ranging from the fundamental to the applied. There have been no catalysis engineers developed and even fundamental scientists specializing in catalysis tend to consider themselves physical chemists with much broader interests than catalysis alone.

There has been too much tendency in the past to block out specialists in both fundamental sciences and engineering as distinct and unique disciplines. The trend has been reversed in recent years and properly so. For instance, it has become increasingly obvious that the chemical engineering concept by which one can characterize and systematize a broad variety of seemingly unrelated physical and chemical operations applies equally and directly not only to petroleum and chemical fields, but also to extractive metallurgy, nuclear energy operations, pulp and paper, plastics, etc.

Operations financed by the AEC do not truly define a separate nuclear industry or technology. Similarly, the only areas in atomic energy that can properly be labeled "nuclear engineering" pertain to design of reactor cores.

The one significant new technical identity arising from these atomic energy programs is the engineering-physicist. Actually, only a small fraction of the total engineering effort on atomic energy projects falls into this category. It is of special interest to us in that it parallels in a remarkable manner the blending of engineering and chemistry that evolved over the past 50 years into chemical engineering, as we know and practice it today. It is logical and consistent to identify this, and only this, blend of fundamental science (physics) and applied science (engineering) as "nuclear engineering." Colleges and industry should take careful note of the analogous evolution of chemical engineering. This would provide the basis for constructive formulation of curricula, scientific disciplines upon which to build careers, industrial specialties that can be fitted into accepted commercial practice, and a sound framework upon which to build a vital and growing segment of technical literature and professional institutes.

It is this engineering physics specifically which should be incorporated in the terms "nuclear engineering" or "nuclear reactor engineering." To extend the areas of competence, training, and responsibility of "nuclear engineering" beyond engineering physics, reactor technology, etc., to include



such categories as chemistry, chemical engineering, mechanical engineering, metallurgy, electronics, etc. is ridiculous and ill-conceived. It resembles some of the original concepts many years ago of chemical engineering as a potpourri of all branches of chemistry plus a liberal sprinkling of as much of the various branches of engineering (mechanical, civil, electrical, etc.) as could be digested.

Radiation Hazards

An inseparable part of operations or experimental studies dealing with radioactive materials is "health physics." This involves provision for normal operation and accidents.

Literally all process industries involve distinctive hazards of some sort. Since radiations cannot be physically sensed by sight, feel, taste, smell, etc., there are natural concerns, misunderstandings, and confusion on the part of the public. However, radiations can be measured and controlled and there are no technical restrictions preventing control of hazards comparable to other industrial activities. Just as in the closely related factor of commercial incentives for private industrial participation in atomic energy, the ultimate and essential consideration is that of costs.

Economics of atomic radiation applications are closely related to provisions for shielding, handling of radioactive materials and isotopes, disposal of wastes, medical therapy, and maintenance. The various operations and applications involving radioactive materials will all require thorough and constant evaluation of radiation exposure and the economics of health-safety precautions for normal operations. Such problems emphasize strongly the inadequacy of our present knowledge of effects of radiation exposures.

Other than for specific medical therapy, there is no evidence to indicate that any level of radiation exposure can be anything but deleterious. Some of our most reputable and responsible biologists have called attention to the staggering degree of ignorance and lack of valid data on many vital aspects of this problem, particularly that of genetics. The difficulties are somewhat analogous to the frustrating inaccuracy of extrapolating short-term corrosion studies in the process industries to predict results and properties of materials of construction over many years.

It can be expected that radiation tolerance levels will be reviewed and redefined periodically as data accumulate. Overly-conservative safety standards can seriously obstruct nuclear energy developments, applications, and progress; premature and overoptimistic relaxing of safeguards could prove dangerous.

INDUSTRIAL ASPECTS OF ATOMIC ENERGY APPLICATIONS

NUCLEAR POWER: A General Consensus

1. We do not yet have adequate research and development data and operating experience on large-scale plants to permit truly valid projections to be made of the cost of nuclear power. On the basis of available data, it is apparent that the cost of nuclear power in most, if not all, areas of the United States would be substantially higher than conventional power. The cost of power from fossil fuels will increase over the next several decades and there will be a downward trend in nuclear power costs with experience from successive generations of large nuclear power reactors.

2. Nuclear power may be a matter of survival in other countries which do not have ample supplies of fossil fuels as does the United States.

3. With the increasing cost spiral of nuclear projects, it is not surprising that the pace of activities by the electric utilities and others in developing and erecting power reactors should be affected. Many manufacturers are also discouraged. Look for renewed pressure to have the government underwrite a much larger percentage of the costs of development and demonstration reactors. This assumes that there will be a restatement of objectives and programs, specifying that it is in the national interest to expedite the power programs, regardless of the immediate or long range commercial, economic incentives in the United States.

4. Vital aspects in the nuclear demonstration reactor program for domestic or foreign applications are: valid fuel costs, influenced by processing, fabricatoin, reprocessing of spent fuel, waste disposal, and purchase of by-product plutonium; plant costs, obviously related to size and generation of reactor installation; and operating costs, affected by many factors including maintenance, insurance, and safety.

Progress over only a dozen years demonstrates that the effect of atomic energy developments on industrial activities of interest to chemical engineers will continue to grow. The accelerated pace of scientific and industrial progress over the past several decades indicates that the future will see many developments not now visualized even by our most starry-eyed prophets.

However, I would suggest that we now declare a moratorium on prophecies and settle down to the unglamorous task of grinding out reliable data upon which to base valid projections of future business ventures.

A very wide range of familiarity with atomic energy activities exists among organizations and individuals. Still in an advantageous position are those who have participated on a contractual basis in AEC programs: supplying ordinary as well as special chemicals, materials and equipment; operation of government-owned facilities; furnishing of processing services, such as development, design, procurement, and construction; research and development; studies, surveys and evaluations. Even among these the level of participation varies from the token or strictly compartmentalized to the fully diversified, with exposure to the entire scope of AEC operations. Recent access and declassification programs have reduced the handicap of those organizations not engaged in contractual work with the AEC. Nevertheless, there is still no better way to acquire know-how in this field than active participation. I agree with those who feel that full access and participation by private organizations and individuals, preferably on a normal, commercial, unsubsidized basis, will prove to be the optimum and most rapid route to development of various peaceful uses of atomic energy in this country.

Atomic energy developments have already proved to be significant factors in the business economies of the chemical, metallurgical, petroleum, and other industries. Although widely used, the word "impact" is probably a misnomer, since the changes for the most part will be evolutionary rather than revolutionary. This refers equally well to food, agricultural, pharmaceutical, medicinal, and other applications.

Power

The technical feasibility of nuclear power is a proven fact. However, none of the cost projections proposed to date can possibly be valid. Substantiation for almost any opinion on nuclear power economics is possible by appropriate basic assumptions. Costs cannot be truly realistic where varying degrees of government subsidies are involved and where the problems of fuel reprocessing and waste disposal are minimized. The efforts devoted by the government and industry to fuel reprocessing and waste disposal appear insignificant compared with work on power reactors.

Nuclear propulsion has been shown to be technically feasible, through our submarine experimentation. Atomic

powered merchant ships, tankers, and other vessels will be realities in the near future. The competitive position of the United States in world shipping should not be altered greatly by atomic propulsion because of our relatively high labor costs. Dock facilities for serving these ships will be required. Proximity of fuel processing facilities will be important.

Nuclear propulsion for aircraft should be technically feasible, but not practical, except for possible special military purposes. Many major problems will have to be resolved before this can become a reality.

Publicity releases on atomic locomotives far outweigh actual efforts. This application should be considered a long-range possibility—not anything for the foreseeable future.

Applications to motor vehicles appear completely impractical.

The overoptimism and overglamorizing in recent years have now been supplanted in many circles by pessimism and disillusionment. Neither extreme is realistic nor justified. Recent reports of disenchantment by some organizations should be weighed against unfounded claims and promotions in many operations related to atomic energy. The really basic problems have not altered radically over the past decade.

Economic feasibility of nuclear power will hinge to a large degree on fuel production, fuel reprocessing, and waste disposal. The last named is another problem which requires the type of approach chemical industry can supply. As noted earlier, no permanent, technical solution to this waste problem is yet available. Present AEC plants are primarily concerned with improvisations—diluting to the environment or storing in vaults. It is to be hoped that sufficient incentives can be worked out to attract the industrial competence required on this problem.

The recent flurry caused by a new AEC schedule of plutonium prices indicates the basic invalidity of cost estimates that include direct or indirect government subsidies. The value of plutonium produced is a critical economic consideration for most proposed civilian power reactors.

CONTROLLED THERMONUCLEAR POWER

A tremendous amount of fundamental data is needed to permit even preliminary design conceptions of thermonuclear reactors. There appears to be no justification for deferring industrial ventures relating to nuclear fission because of speculations on possible impact of fusion power. Fundamental thermonuclear work will be supported primarily by the government for the immediate future. Commercial applications appear remote at this time, although there is a limited amount of well-publicized, private activity in this field.

The AEC and British thermonuclear programs should be carefully followed by those who might take advantage of possible markets for products and services, including new or expanded production facilities and process modifications.

The AEC has announced that during the fiscal year 1957 over $11 million was expended in development work on alternate methods of controlled release of energy from nuclear fusion. Research is being conducted at several AEC sites.

As is evident from the recent joint disclosures by the United States and Great Britain, work on controlled thermonuclear fusion is in a truly fundamental stage. It is simply too early to attempt any valid extrapolations. While technical feasibility may be demonstrated on certain aspects over the next decade or two, plant scale production of power appears much more remote. Look for increased declassification in this field, spurred on by anticipated competition for publicity values by the United

PLANNING YOUR ROLE IN NUCLEAR DEVELOPMENT

- *Get the facts.* For those who have not participated extensively in atomic energy work, compilation of all the data upon which to base sound judgments is considerably more difficult than normal literature searches. Compartmentalization, security, duplication, and inaccessibility of complete library facilities are still major problems in dissemination of information.

- *Evaluate possibilities for* increased profits or enhanced competitive positions on short- or long-term bases. It is important to recognize the many political, economic, technical, government subsidy, patent, security, and other factors that may be involved in various atomic energy activities. Some applications may have tremendous promise but require time and extensive work to develop.

- *Take the initiative.* The government has repeatedly emphasized that industry should take the initiative and not wait for invitations to participate, even in existing operations. Similar directive influence can be exerted by industry to have the AEC direct along certain lines research efforts supported by the government. An example would be more fundamental and less applied research in AEC national laboratories.

- *Recruit and train technical personnel.* Personnel in companies should be encouraged to become familiar with atomic energy technology as it relates to their specialty fields. Special courses or training for individuals or groups may be justified. Many programs are available, but they should be evaluated, since they vary widely in purpose and effectiveness. Do you really need nuclear engineers or scientists, or do you require engineers and scientists in established specialties with appropriate understanding of atomic energy principles?

- *Help the colleges to help you.* The popular vogue in colleges of jumping on the bandwagon and initiating special nuclear engineering and science courses is ridiculous. Most of the colleges have only a vague concept of suitable curricula and the needs of industry. Industrial liaison and guidance are required. The only completely new entity emerging from atomic energy activities involves the blending of engineering and physics which may properly be termed "nuclear engineering."

- *Encourage publications* relating to atomic energy with realistic company-confidential restrictions. Wherever possible these should be channeled through established societies and journals.

- *Press for organization of atomic energy data* along the established lines of fundamental and applied science and not the so-called "state of the art" approach. Just because a program is financed by the AEC does not render the work "nuclear engineering."

- *Soft-pedal talk of "technological break-throughs," "revolutionary developments,"* and "nuclear flashes of genius." It is time to get on with the unglamorous task of grinding out research and development. Peacetime applications are far more important for their potential than their present value. Industry should apply sound evaluations and suppress excesses in optimism and promotion.

- *Get more experimental data.* Papers are getting very redundant. Many of the top researchers in atomic energy activities would welcome some relief from the many time-consuming technical meetings, symposia, and conferences to permit them to return to their laboratories for some fresh data.

- *The pace of atomic energy developments over the next several decades will be largely determined by the extent and efficacy of government subsidies.* All cost studies of power for nuclear reactors in the United States must of necessity assume direct or indirect subsidies. Subsidy in atomic energy programs may not be a popular term, but it is the single most important factor influencing the time element of development for any given application. Government subsidies are unavoidable if we are to get on with the program, particularly reactor applications, until such time as private industry can assume the full burden. Nevertheless, the maximum rate and efficiency of peacetime applications of atomic energy will be attained only when normal, commercial, competitive incentives of private industry exist.

States and other nations at the forthcoming 1958 Geneva conference.

PROCESS AND SPACE HEAT

A number of organizations are seriously studying the possibility of process heat from atomic reactors. A major limitation in presently contemplated reactors is the level of available temperature. Most immediate applications can occur in areas of high fuel cost and large heat demand. Commercialization (other than as by-product heat from reactors used for other purposes) appears remote at present in this country.

Application of Radiation and Radioisotopes

No part of the chemical, metallurgical, or petroleum industry can afford to ignore the progress, if not the potentials, in the use of radiation and radioisotopes in research, control, and production.

AGRICULTURE

Applications in agriculture, proceeding at a relatively modest rate, should become increasingly significant in tracer research, plant breeding, blight and pest control, and crop storage.

FOOD

Radiation sterilization or pasteurization of food should be a minor though growing factor in food-processing within a decade, if present programs are successful. Possible advantages: elimination of refrigeration or extended shelf life. Problems: costs, product quality, consumer preferences, and tradition. Radiation could be used to kill all or most of the bacteria and insects with no residual radiation. Larger radiation doses to kill all bacteria change texture, color, taste, odor, or nutritional value in most foods. In the foreseeable future, radiation preservation of foods, where economically advantageous, will supplement but not replace other methods. New health standards and public acceptance are major hurdles.

MEDICINE

Ionizing radiations are not new in medicine, having been used for over half a century. Radium and X-ray machines, with some artificially produced radioisotopes, were used before World War II. Availability of relatively large amounts of isotopes from the Oak Ridge National Laboratory has already demonstrated the vital potential of radioactive isotopes as research tools, diagnostic aids, and therapeutic agents.

PHARMACEUTICALS

Numerous papers have been published since World War I on the effect of ionizing radiations on all types of organisms. Radiation sterilization should involve fewer problems for antibiotics and other drugs than in the case of foods, since side effects are less critical.

CHEMICAL REACTIONS

With regard to the industrial value of radiation and radioisotopes, it is essential to adopt a realistic perspective. We will find the use of radiation of growing importance in research and in process control.

Applications of radiation to chemical phenomena are obviously in the very exploratory stage. We should not demand dollar-making potential to justify basic research efforts. This applies to organic, inorganic, catalysis, and other proposed applications. The present ratio of basic to applied research is, in my opinion, far too low. Too many fundamental scientists are involved in premature cost estimates of commercial plants and applications.

Potential applications of radiation exist in literally all branches of chemistry and chemical engineering. The full scope of possibilities will emerge as we advance from our present embryonic stage of knowledge. Much of the research in AEC laboratories has been related to applied problems such as radiation-induced decomposition of water, stability of extraction solvents, ion exchange resins and other materials, development of lubricants, and testing of organic moderators for reactors.

PETROLEUM

The petroleum field is probably the most active at this time in studying or applying atomic energy to its research, exploration, and production. In oil refining these uses include gauges for liquid level, density, chemical analyses, marking of pipeline interface, measurement of flow rate and catalyst circulation, mixing studies, and determination of tar entrainment. Research activities among the large oil companies have been reported in essentially every phase of petroleum and petrochemical experimentation. However, we should not expect to see radiation techniques replacing present commercial catalytic cracking and reforming of hydrocarbons.

RUBBER

The only chemical radiation processes commercially significant today involve polyethylene cross-linking reactions. The total production of such materials (which include wire and cable jacketing and electrical and packing tapes) represents a very small part of the present plastics market. These approaches will also have to compete with other schemes such as photochemical and simple chemical cross-linking. Vulcanizations by radiation of most of the common elastomers have been reported over the past few years.

Apparently all of the large rubber companies are participating in some aspect of radiation research. Among the subjects of interest are: the use of high-intensity radiation to vulcanize or cross-link elastomers and to improve the physical properties of plastics: development of radiation resistant elastomers and rubber products; graft polymerization; and the use of radiation as an initiator or catalyst for polymerization. The activities of the rubber industry can, however, be best described as being in the exploratory phase.

PLASTICS

The advantages of the use of radiation as a catalyst in the production of plastics as well as other reactions will have to overbalance the additional cost of production, compared with alternate schemes using only heat, pressure, and catalyst. The advantages include: the possibility of initiation of reactions at relatively low temperatures; initiation of reactions in the solid state; reduced pressures; and minimizing or eliminating impurities resulting from addition of catalysts.

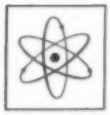
CHEMICAL ENGINEERING RESEARCH

It is likely that radioisotopes and radiant energy techniques will be widely applied in chemical engineering research, development, and pilot plant investigations. They should prove of tremendous value in clarifying true mechanisms and characteristics of chemical engineering operations. Most of our so-called chemical engineering theory still consists of highly dubious extrapolations of dilute physical chemistry to concentrated commercial systems.

In adding radiation to the three classical control elements of chemical reactions—heat, pressure, and catalysis—we have a valuable tool for greatly extending the flexibility and utility of processes. Again, we sorely need fundamental data and not prognostications to block out the real potential of these nuclear energy applications.

Presented at a meeting of the Rocky Mountain Local Section, A.I.Ch.E., Denver, Colorado.

LET'S SHIFT THE EMPHASIS



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In a recent publication (*1*) there appeared the not too surprising statement: "According to the AEC, the demand for radioisotopes in a few instances has begun to exceed the available supply. The items principally involved are tritium and krypton 85. Industrial interest in cobalt 60 indicates that for it, too, demand may soon exceed supply."

While only one of the foregoing specifically cited items is a fission product, the others are truly products of neutron exposure. The disturbing thought suggested by this fact is that emphasis in the nuclear energy field may have been, in the recent past, placed not entirely in the proper directions. For years we have been hearing of the controversies concerning the United States Atomic Energy Program as compared with that in other countries such as England and Russia. These discussions have centered around the question of who is to have the greatest number and largest capabilities of nuclear power plants at the earliest date. The United States has steadfastly maintained that it is not going to enter a "kilowatt race" but is concentrating on the development of the greatest variety of types of nuclear reactors with a view to arriving within the next ten years at a selection of the most economical and successful types rather than concentrating on only one or at the most two of presently accepted types which may not yet be in a position to produce power at the most economic level. The complete wisdom of this course of action has again been somewhat thoroughly reexamined (*2*) by one of the earliest champions of the philosophy of multiple approach, W. Kenneth Davis. In October of 1957 he stated: "Now my own opinion is that, although water reactors will not ultimately have the lowest nuclear power costs, they can be developed during the next 10 to 15 years to a point where they have a vast field of utility abroad and can compete with conventionally fueled plants in a substantial portion of the United States. It is this conviction which lies behind my belief that we need to adopt a policy of concentrating on water reactors, even though this may require slowing down the effort on more advanced types of reactors. This is a basic technical decision which needs to be made some time in the near future, if not at this instant . . ."

The seeming paradox that a growing shortage of isotopes seems to be immediately imminent poses the question of why this should exist when adequate quantities of these materials should either be available from the waste storage receivers or, even better, in the fresh production effluent of the plants at Hanford and Savannah River. Such a paradox needs to be thoroughly examined and investigated. From other sources information has also been received that there are developing shortages for other isotopes present in the by-product material from nuclear fission, particularly the beta emitters which are giving great promise in the field of production of small power packs and in the generation of luminous sources.

The problem of shortage of sources of fission products and radioactive materials is not helped toward solution, at least in the United States, by the recent announcement that a nuclear fuel reprocessing plant will be built at Mol, Belgium, by Eurochemic, a joint company set up by 12 member countries of the Organization for European Economic Cooperation. Capacity will be 100 tons of uranium per year. Cost: about $12 million. Construction will start immediately for completion by 1961. A plant of this nature will be more than adequate for the Continental market which could conceivably even handle spent fuel from the United Kingdom. Conversely, Britain will process spent fuels from the recently announced 200,000 ekw plant in northern Italy. Hence the large scale European nuclear power program (*3*) means only that the impending shortage of radioisotopes in the U.S. may be a fruitful market for the European producers.

Further evidence of the changing trends in nuclear thinking in the United States was presented at the recent A.I.Ch.E. meeting held at Chicago in December, 1957. In a series of papers we learned that there was an imminent need for increase in production of radiation materials for food preservation, according to Eugene Lamb (*4*). Another paper presented by J. J. Martin (*5*) entitled "The Effect of Gamma Radiation Intensity on the Polymerization of Ethylene" stated: "One method of polymerizing ethylene which may become of more than laboratory interest in a few years utilizes gamma radiation as the catalyst of the reaction." A provocative paper by R. Carson Dalzell and James

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P. McGee (*6*) under the title "Indirect Cycle Nuclear System to Furnish Process Heat," describes the process for the gasification of coal by means of nuclear heat. Experimental work by the Bureau of Mines has demonstrated the feasibility of gasifying finely powdered, low-rank coals (subbituminous coals and lignite) in alloy steel tubes and temperatures in the range of 1,800° F. A fourth paper suggested the use of nuclear power as a source of process heat in the chemical industry in contrast to its use for the generation of electricity (*7*). In a paper by Edward R. Heller and Deane O. Hubbard it is forecast that: "We are positive that present technology will permit the building of nuclear power plants today in sizes of 100,000 pounds of steam per hour and larger, in economical competition with fossil fuel steam plants for pressures up to 200 pounds per square inch." In general, the chemical industries require an uninterrupted reliable and constant source of heat for their continuously operating processes. In the majority of plants, load factors of 90 to 95% of demand are the rule rather than the exception. These conditions are ideal for nuclear reactors. On a cost of steam basis, the nuclear reactor is competitive with about $7.00 coal at about 95% load factor and less than $0.06 oil. Of course, the capital cost of the nuclear unit is higher than the comparable sizes of fossil fuel-fired generators. Fuel savings would tend to offset the differentials with consequent speed up in repayment of capital costs, they indicated. Another important research project is already under way at Columbia University under the direction of E. J. Henley, who seeks to learn if radioactivity may some day be a means to make synthetic natural gas from coal (*8*).

Even in Great Britain, where the emphasis correctly is greatest on power production at low temperature levels, the use of radioactive isotopes and high energy radiation in polymer chemistry, etc., is receiving increasing attention. In the Tennant Memorial Lecture delivered by Dr. H. W. Melville (*9*) we learn: "With polymers, particularly in the solid state, purely chemical methods usually require incorporation of some chemical compound in the polymer, as for example in the vulcanization of rubber. The radiation technique does not normally require the introduction of any further compounds, with the result that no residual products of decomposition remain in the system!"—a needed objective.

Ward S. Diethorn of Battelle reiterated recently (*10*) the promise of a most challenging procedure: "The kinetic energy of fission fragments produced during fission of U-235 offers greater promise in radiation synthesis. In this method the chemical reactants would be circulated through the core of a nuclear reactor. The unit would be designed to promote the escape of fission fragments from the nuclear fuel and their absorption by the chemical reactants which act as the coolant. A setup of this type would have a radiation output of 1,000 to 10,000 times that of the electron beam generators now in use!"

The complex problem of materials of construction, too, has received its share of attention. Leon Davidson and A. S. Strasser in a paper (*11*) entitled "Process Applications and Construction Materials for a High Temperature Nuclear Reactor for Chemical Processing" and another (*12*) by J. De Felice entitled "High Operating Temperature Reactor Design" all dealt with reactor operating temperatures in the range of 2,000 to 3,000° F.—a promising and fertile research area.

These scientists and engineers are today's pioneers inspiring the reactors of tomorrow in which elevated temperature and high intensity radiation will be the main objectives, with heat and power the by-products. If the emphasis in research is shifted to this extent, it is quite conceivable that we shall find economical power to be easily within reach before too long, as by-product of the chemical processes. It is somewhat disturbing to note that little—too little—if any, attention was paid to this facet in the multiheaded nuclear power development conference held behind closed doors on November 21 and 22, 1957, by the Joint Committee on Atomic Energy in Washington, D. C. The meeting report has just recently been made available, and while it is provocative, seems still to have inadequately covered the ground of interest to the chemical process industries. Again, private industry alone cannot carry the full load in developing and constructing reactors for high temperature and chemical process applications research, as well as for power reactor research. More government support and financing are needed here, too, and now!

It is interesting to note that in the foregoing presentations, no reference was made to the possible additional profits that can be obtained from processing the by-product materials which become available as a result of the basic nuclear reaction. Such important factors were cited however, in a recent presentation by Charles G. Manly (*13*). Manly pointed out that a 2 million dollar fuel reprocessing plant could be written off in five years at a rate of about $400,000 a year from income produced by also recovering the krypton 85 and the stable xenon that would be created. This same approach has been investigated in connection with a proposed 150 electrical megawatt homogeneously fueled power plant in which an irradiation facility for the utilization of volatile fission products would be constructed to function in conjunction with the power plant reactor. It can be shown that with an associated food irradiation facility, the fuel reprocessing charges would be less than 0.5 mils per kilowatt hour (the announced AEC goal) when only 40% of the total irradiation potential of the plant is utilized. To this can be added income from recovery of typical isotopes such as cesium 137, krypton 85, etc. The quantities recoverable are of such magnitude that at a price of $0.50 per curie of cesium 137 and a price of $1.50 per curie for the krypton 85, the combined value of the two isotopes would be well over $400,000 a year, and this omits entirely the value of the many other recoverable isotopes in the fission wastes.

The increasing demand for radioisotopes is constantly stressed by Willard F. Libby of the Atomic Energy Commission (*14*). Libby calls attention to the fact that within three to five years there are possibilities for savings of the order of $5 billion in industrial processing and agricultural benefits, at least in an indirect way, possible through applications of the radioisotopes. It is difficult to arrive at a direct relationship between these huge savings and the sales value of the isotopes themselves. However, recent studies indicate that when the savings were of an order of $100 to 200 millions a year a few years ago, the value of radioisotopes was within the region of $1 to 2 million. By extrapolation, it would become evident that the value of the radioisotopes alone might be as high as $25 to 50 million within the next five-year period. This does not include income from general irradiation services which will develop in spite of competition from other sources such as electron accelerating machines (*15*). The Chemical Process Industries' outstanding success over the past several decades in reducing costs and lowering prices across the wide spectrum of chemicals and plastics assures equal success in this field—if private industry is bold enough to venture into it. The question, therefore, poses itself, "Who is making plans for the production of these isotopes in these quantities to capture the potential profits

that might accrue through a private industrial venture into this field? Is the Government going to be forced to carry this burden itself or is there an enterprising private organization in the United States that will undertake to meet this challenge?" This situation is in sharp contrast to that which now confronts the mining and milling industry. W. B. Hall of Vitro Uranium is quoted (*16*) as saying "Presently projected levels of domestic uranium production indicate throughputs in excess of 20,000 tons per day and annual production in excess of 15,000 tons of U_3O_8. This represents $250 to $300 million per year uranium industry through 1966. Thus though uranium processing will level off, it will be at a substantial rate of production. Exploration, however, undoubtedly will be drastically curtailed. Life of the industry beyond 1966 is left in serious jeopardy."

While the important factor of economics has certainly been a deterrent to rapid progress in the development of the nuclear reactors, it is becoming increasingly evident that there are large profits to be made from the nuclear scrap. This field is relatively exclusive. There are not very many companies equipped with the knowledge or the facilities to process and handle such material. As the nuclear energy industry grows, so correspondingly, the nuclear scrap pile is also growing and more and more companies may be expected to enter this industry. Certainly the greatest benefits will go to that company which enters it first. There is no question that the subject of profit margins from nuclear energy has been in a somewhat confused state. Nonetheless it is becoming increasingly apparent that the business is now emerging from this state with a clearer road ahead and in the future trend the profits should show steadily increasing margins. There still remains, according to a survey made less than a year ago, the obstacle of secrecy and classification (*17*). A manufacturer was quoted as saying, "The greatest single obstacle to our rate of development of atomic energy for peaceful purposes has been the security requirements of the AEC. The obstacle has shown itself in many forms:

1. Access to information,
2. Inflexibility in use of labor forces,
3. Duplication of effort,
4. Adverse effects on public relations,
5. Considerable increase in cost of operation,
6. Ineffectiveness of employee's efforts during investigative procedures for clearances.

There is no question that the declassification of nonmilitary atomic energy information will not be felt for more than six months."

Information more recently obtained indicates that improvements in this situation have not come along as fast as they should. It is still virtually impossible to obtain direct information on engineering designs, material availability, and basic costs in any operation even remotely related to the military production facilities. This is the case even though those requesting the information have absolutely no concern with the total production quantities and wish only to be assured of quantities in minimal given amounts and categories. Then too, the problem of getting these materials directly from the governmental operations into a private processing plant seems to engender new difficulties, the solution for which is still not readily available, even upon direct contact with members of the AEC staff. Can a private firm establish its own facility adjacent to a chemical reprocessing canyon at Hanford or Arco, for receipt, separation, purification, and sales of radioisotopes? What terms of land lease, return of unused solutions and gases to the U.S. AEC plant for long-term ultimate disposal, raw material charges, and other myriad operational, safety, security, financial, political factors can be negotiated with a governmental plant operated by another private contracting firm? It, therefore, further emphasizes and stresses the need for the production of the products of fission in nongovernmental operations where the restrictions of military implications and secrecy are entirely absent.

"It is our government's stated policy to stimulate industry's role in the development of atomic energy application, yet there are still major stumbling blocks in getting the necessary fresh information to the potential contribution . . ." (*18*).

The question of safety and the additional costs which result from the

stringent regulations of the regulatory agencies, should also be closely examined. It is not impossible that when fire was first introduced to mankind by the brave few pioneer researchers in a remote age in the history of mankind, they must have been subjected to the critical remark—"Boon to mankind, ha! one of these days it'll get loose and burn up the whole world!" (*19*). While this is yet not something that can be proved there is no question that in many cases a similar prophecy is being made with respect to the radioactivity which will be born in power and industrial heat generation equipment. Certainly with adequate and reasonable precautions human life can be safeguarded without the imposition of one supersafeguard upon another which continues to increase the cost of radiation operations to the point where they become wholly uneconomical and unprofitable. There is no question that human life and property need and should receive the fullest safeguards which the operators of radiation facilities can provide. These will be achieved and certainly with increased practice and knowledge will come realization of simplified methods for the achievement of maximum safety without maximum cost.

In short, therefore, we can say that the time certainly is here when there is *need for shift of emphasis in the field of nuclear energy.* We should look more to the great advantages through savings and other benefits that can be derived from the application of the nuclear process to the production of heat for industrial processing, for industrial process reactions and for the production of the radiation end products which seem to have such tremendous potential for the future of our high-geared economy.

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where we stand in

RADIATION PROCESSING

Papers discussed in this and in the following article by B. W. Gamson were presented at the Chicago Annual Meeting of A.I.Ch.E. in December. They will be printed in full in forthcoming A.I.Ch.E. Symposium Series Volume Number 21.

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Sources of energy are of primary importance in the bulk of chemical processing operations. The appearance on the horizon of a new source of energy, therefore, is worthy of attention on the part of the chemical industry. The atomic energy program has brought with it just such new sources of heat and radiation. It is with the latter that this discussion is principally concerned. Except for infrared and ultraviolet, radiation has been a rather scarce commodity until recently. However, through the development of nuclear fission and high energy accelerators, large quantities of ionizing radiation have become available for processing purposes. Although the impact of this supply of radiation on the processing industries will probably not be felt for some time, there is a program of research which is being carried on in both private and government organizations to discover specific applications and to develop techniques for using radiation in anticipation of a radiation processing industry.

Types of Radiation and Their Sources

Types of radiation which can be expected to find some use in process applications can best be considered from the point of view of their sources. Gamma radiation (high energy electromagnetic) is liberated directly in a nuclear reactor, is given off by the radioactive products from nuclear fission, and is also produced by artificial radioactive materials, such as cobalt-60, which are made by neutron bombardment in a nuclear reactor. Soft gamma rays or X-rays may be produced as secondary radiation when accelerator beams are focused on metals such as tungsten. Beta radiation (charged electron particles) is given off by some fission products, by artificial radioactive isotopes, and is the direct product of electron accelerating devices. Machines such as the van de Graff, the resonant transformer, and the linear accelerator produce extremely high-intensity beams of electrons of high energies. These beams may be compared with those of radioactive materials or those in a nuclear reactor, which are much less intense because they are liberated throughout a solid angle of 360 degrees instead of the few degrees or less for the accelerator beams. Neutron radiation is produced in large quantities in nuclear reactors and also may be obtained in small quantities from certain nuclear reactions such as between polonium and beryllium. Finally alpha radiation (positively charged helium nuclei) is the product of some radioactive isotopes such as polonium.

In addition to the ordinary forms of radiation listed above, one may include the ionizing or radiation power of recoiling fission product atoms in a nuclear reactor. If the fission fragments are in some medium where they have freedom of movement, they can ionize particles with which they collide since they are moving with very high velocities.

Of the various types of radiation just considered, it appears probable that only four will be of any significance in the chemical processing field. These may be given in the order of their apparent importance at this writing as (1) gamma rays, (2) high energy electrons, (3) neutron radiation, either directly or indirectly for the radioactivity it induces, and (4) recoiling fission fragments. The respective advantage of each of these radiations is (1) extreme penetrating power, (2) high intensity, (3) activation ability, and (4) enormous energy potential. Some interesting research has been conducted recently on the uses and sources of the various radiations, and in the following a brief account is given of the work in this field, which was reported at the last A.I.Ch.E. meeting in Chicago. Although it cannot be of more than limited scope, it does indicate the general trend of thinking in the area of radiation processing.

Fission Product Pilot Plant—Oak Ridge

In the decay scheme for cesium-137, one of the products of fission of uranium, a gamma beam of 0.66 Mev. is liberated. Since cesium-137 has a half life of 33 years, it is not surprising to learn that a pilot plant is being constructed at Oak Ridge to separate this element and package it for use as a powerful source of gamma radiation. According to Lamb (*1*) the new pilot plant will process annually about 150,000 gal. of a typical aqueous fission product waste solution to obtain 10 kg. of cesium-137 in the form of the chloride, $Cs^{137}Cl$, with an activity of 200,000 C. Smaller amounts of other fission products such as Pm^{147}, Ce^{144}, Sr^{90}, Ru^{106}, and Tc^{99} will also be produced. The pilot plant consists of a number of cells with thick concrete walls as shown in Figure 1.

One row of cells is used for processing liquid streams. Another row is equipped with slave manipulators and lead glass windows, and is used to process and package the final dry solids. General construction details appear to be similar to those of other installations where radioactive materials are processed, which means they are not cheap.

Thus, one cannot expect to buy cesium-137 for any less than the 30 cents a curie suggested as the rock-bottom price by Willard S. Libby, the A.E.C. commissioner.

Fig. 3. Brookhaven slab type irradiator.

Lamb reports that the cesium-137 is to be packaged in type 316 stainless steel tubes such as diagrammed in Figure 2. The wall thickness of each cylinder is 0.04 in. giving a total thickness of 0.08 in. for the double-walled capsule. This structure absorbs less than 10% of the gamma radiation given off by the cesium. The cesium chloride powder will be compressed in these source units to a density of 3.0 g./cc. The specific activity of the chloride is 20 curies/g., so that each unit with a volume of a little over 80 cc. will contain 5,000 curies of activity. Actually the activity will be greater than this due to the presence of a small amount of cesium-134. The decay scheme for this element includes a 1.37 Mev. gamma ray, which, of course, would be useful, but also which would have to be considered in making shielding calculations, since its penetration is somewhat greater than the radiation from the decay of the cesium-137.

The new cesium-137 sources should be of great interest to potential users of gamma radiation. Lamb states that these sources will probably be shipped in lead pigs via truck or railway express, and recommends that shippers consult the regulations for transportation of dangerous articles as given in Tariff No. 10 of the Interstate Commerce Commission.

FIR Gamma Irradiato.

One of the more unique processing devices which has been proposed to use gamma radiation is the Food Irradiation Reactor (F.I.R.) of the Army Quartermaster Corps. This reactor is to be an M.T.R. (Materials Testing Reactor) type with a surrounding blanket containing a solution of an indium salt. Indium has a high capture cross-section for neutrons and is readily converted to indium-116 which decays with the liberation of several gamma beams varying from 0.4 to 2.1 Mev. Because the half life of indium-116 is only 54 min., the decay is rapid and the liberation of gamma radiation prolific. Therefore, the indium salt solution is circulated rapidly through an outside container (the irradiator) where its gamma rays can be absorbed by the processed material, and back to the reactor for reactivation. Manowitz, Richman, Kuhl, and Galanter (*2*) of Brookhaven National Laboratory have made an experimental determination of the dose distribution in two irradiators which were constructed as models about one-third the size of production scale units. The object of the study was to determine the gamma dose distribution in the irradiators since the specifications called for a maximum allowable variation in the dose of only 25%.

The two irradiators constructed at Brookhaven were a slab type, Figure 3, and a hexagonal drum type, Figure 4.

In the slab type it can be seen how the indium solution is pumped through the long narrow slab tanks so that its gamma radiation can be brought to bear on the food packages stacked alongside. The hexagonal-drum irradiator was loaded with a tube bundle containing number 2 food cans. The tube bundle was surrounded by indium solution contained in the drum.

Since only relative dose rates at different positions in the two types of irradiators were desired, it was not necessary to use high activity levels as would be done in the commercial devices. Small amounts of indium nitrate were dissolved in distilled water and activated in the Brookhaven reactor by being subjected to the high neutron flux for several minutes. These solutions were then added to large volumes of solutions in the irradiation tanks. Photographic film and small Landverk electrometers were found to be satisfactory dosimeters for measuring the dose at different points throughout the field, with the electrometers being superior for precise quantitative results. The dosimeters were packed in paraffin which was used to simulate food.

The results of the study indicated the radiation fields in the hexagonal drum to be sufficiently uniform for the job to be performed. For the slab irradiator variations were greater than specifications by as much as 50% since edge effects were very pronounced. The results were in agreement with expectations from theory based on the decrease in intensity of radiation as it expands from a point source and as it passes through absorbing materials. One can easily conclude from these studies that indium-solution irradiators might well be applied to other processing problems, in particular, to chemical reactions. The reaction vessels might be placed alongside a slab irradiator or inside drums filled with the radioactive solutions.

Fission Fragment Recoil Radiation

When uranium-235 fissions, approximately 85% of the energy released is in the form of kinetic energy of the fission fragments. In the usual fuel element systems devised so far, this energy is dissipated directly as heat since the fission fragments are constrained so as to move only a few microns before losing all their velocity. However, in liquids and gases the fragments can travel appreciable dis-

Fig. 4. Brookhaven hexagonal drum-type irradiator.

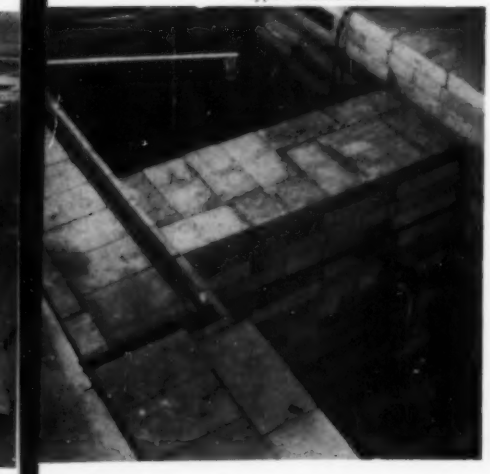
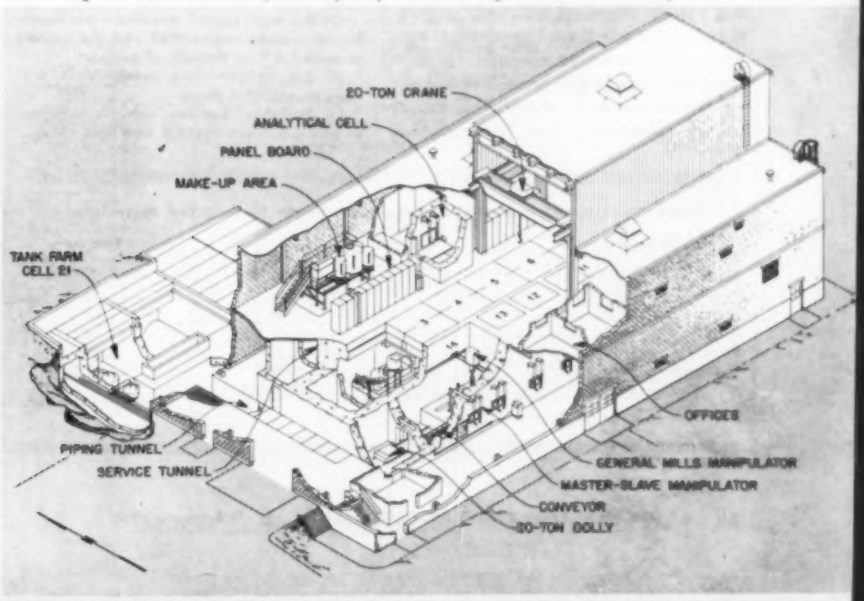


Fig. 1. Multicurie fission products pilot plant, Oak Ridge National Laboratory.



tances, thereby creating a considerable amount of ionization. Because of the tremendous amount of kinetic energy possessed by the fragments, it follows that enormous amounts of radiation power are theoretically available for processing purposes. Diethorn, Schall, and Calkins (*3*) of the Battelle Memorial Institute have studied in some detail the problem of the direct utilization of fission recoil energy in chemical processing. To determine how much of the recoil energy might conceivably be absorbed by a batch of reacting chemicals, they first calculated the ranges which are traversed by the fragments in various media, as given in Table 1.

The fractional amount of fission energy released outside some simple nuclear-fuel geometries was also calculated and the results are shown in Figure 5. It is evident from the values presented that nuclear-fuel elements cannot be very thick if the fragments are to travel any appreciable distance and ionize some chemical reactants.

It is further concluded from this analysis that the volume fraction of the chemical reactants in the system should be large so that the fragments will not enter neighboring fuel elements where they can convert their energy to heat rather than to ionization. Figure 6 shows how the fraction of energy absorbed in the chemical reactants is increased if the ratio of the volume fraction of the fuel to that of the chemicals is decreased. When examining gaseous chemical reacting systems, it was found that reactor physics considerations required a relatively large volume fraction of fuel. Thus, at 10 atm. p. less than 5% of the recoil energy could be transferred to the gas, so that gas-phase reactions requiring large amounts of ionization would be eliminated. Liquid systems therefore appear to be more favorable. To get some idea of the yield per pass in a typical chemical reaction, calculations were made for a hypothetical system in which an exothermic reaction would be conducted with various G-values (molecules reacted/100 ev. of energy absorbed). For the reaction conditions assumed, it was found that higher yields were obtained in liquid systems as shown in Figure 7. This was primarily due to the fraction F of the energy absorbed being higher in the liquid for a given volume ratio of fuel to chemicals.

Conclusions drawn from this study indicate that as larger sources of radiating power are required, more interest will be developed in the utilization of recoil energy. However, any optimistic application of this form of radiating power must not overlook the problems of contamination. The chemical products would contain radioactive fission products and also possible radioactivity from activation of the chemical reactants themselves by neutrons. Such contamination would require high efficiency separations processes to eliminate all radioactivity. Also the economics of using recoil energy have not been evaluated, but it seems doubtful at this stage that a reactor could be operated economically for its ionizing power alone. It is more probable that dual-purpose reactors producing ionization and process heat simultaneously will find early application.

Chemical Reaction Vessels in Nuclear Reactors

Any scheme to use the radiation power of nuclear reactors directly requires the construction of appropriate chemical reaction vessels or processing loops directly inside the reactor. The problems of designing such equipment have been well summarized by Daniels, Schroeder, Foley, and Filbert (*4*), who were responsible for the construction of an in-pile loop in the new Battelle Memorial Institute reactor. They list the special problems which arise in the use of a nuclear reactor as

(1) The need for mechanical and biological safety
(2) The high capital investment represented by the nuclear reactor itself and the necessity to protect it from damage of any sort
(3) The limited space available in high-intensity radiation zones
(4) Radiation hazards and reactor safeguards specifications which must be satisfied.

Consideration of these requirements dictates that any chemical reaction equipment to be used in a nuclear reactor must possess

(1) High mechanical strength
(2) Adequate radiation shielding
(3) Maximum operational reliability
(4) Compactness
(5) Materials of construction which cause minimum problems due to induced radioactivity
(6) Components which can be disposed of easily if they become highly radioactive.

Figures 8 and 9 show the Battelle swimming-pool reactor and the general arrangement of equipment around a single beam hole which is to be used for a chemical processing loop. Figure 10 shows a typical reaction-vessel torpedo which has been designed to slip inside a beam hole.

This torpedo is about 9 ft. long and weighs about 700 lb. The principal item in this tube is the reaction vessel at the small end, which is immediately adjacent to the core of the reactor when the torpedo is in place. This vessel was designed to withstand 1,000° F. and 800 lb./sq.in. gauge and can be made of plain carbon steel, austenitic stainless steels, or high strength alloy steels. The vessel is insulated from the torpedo housing, which is made of aluminum, by a diatomaceous earth such as Sil-O-Cel. The vessel is connected to the outside by electrical and process conduits which spiral through layers of shielding material. Inside the main portion of the tube the shielding is barytes concrete, while at the outside is a thick layer of lead to reduce gamma radiation to a minimum. The torpedo is designed so that the end with the chemical reaction vessel can be disconnected completely at the junction box and disposed of when it has become too radioactive for further use. In this design it is assumed that cooling can be accomplished by the water in the swimming pool simply circulating around the beam tube. However, if this is inadequate, it would be necessary to install two more conduit lines for coolant fluid. After irradiation the torpedo is withdrawn into a special transfer coffin which may be moved to a hot cell where all further work on the assembly may be performed.

Outside the torpedo assembly it is necessary to include instrumentation which will guarantee the safety of the operating personnel and of the reactor. Excessive temperatures and pressures in the reaction vessel must absolutely be prevented and all equipment should possess the usual "fail-safe" features. Furthermore, it is necessary that any reaction proposed to be run in the torpedo reaction vessel be scrutinized closely by several competent persons to determine whether the worst possible conditions such as maximum temperature or sudden increase in pressure, as by detonation, have been properly considered. Since there is little previous experience to rely upon for operating chemical reaction equipment in high neutron fluxes, all plans and designs must be on the ultrasafe side.

Table 1.—Approximate Fission-Fragment Ranges in Selected Materials [a]

Material	mils	microns
Uranium	0.28	7
Uranium dioxide	0.40	10
Stainless steel	0.28	7
Aluminum	0.56	14
Water	1.2	30
Hydrogen gas	5,600	1.4×10^5
Other common gases	1,000-1,400	$2.5\text{-}3.5 \times 10^4$

[a] All gases at S.T.P.

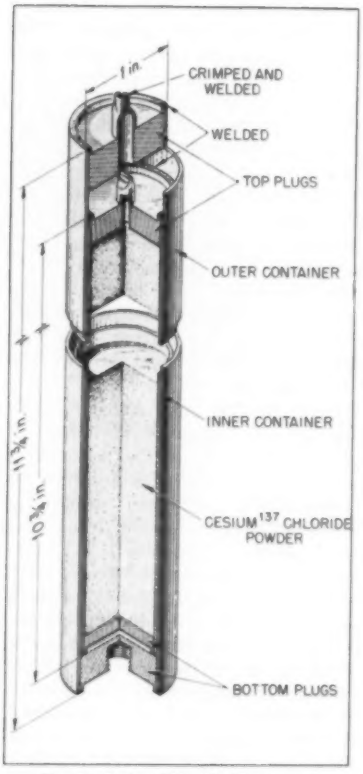


Fig. 2. Cesium-137 chloride source.

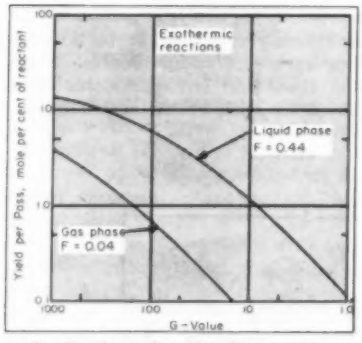
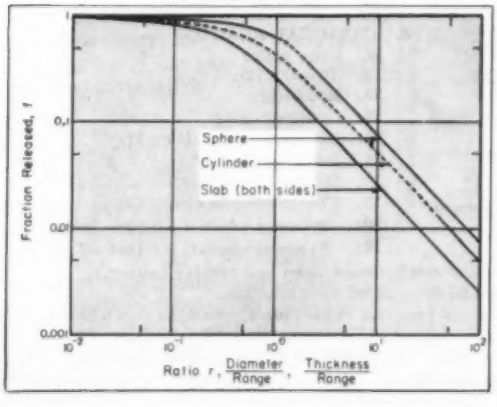


Fig. 7. Chemical yield in fission energy radiation processing.

Fig. 5. Fraction of fission energy released from selected fuel geometries.



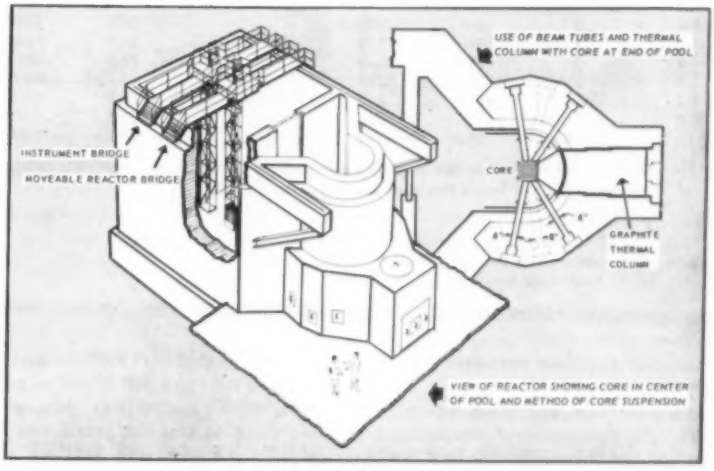

USE OF BEAM TUBES AND THERMAL COLUMN WITH CORE AT END OF POOL
INSTRUMENT BRIDGE
MOVEABLE REACTOR BRIDGE
CORE
GRAPHITE THERMAL COLUMN
VIEW OF REACTOR SHOWING CORE IN CENTER OF POOL AND METHOD OF CORE SUSPENSION

Fig. 8. Battelle swimming-pool reactor.

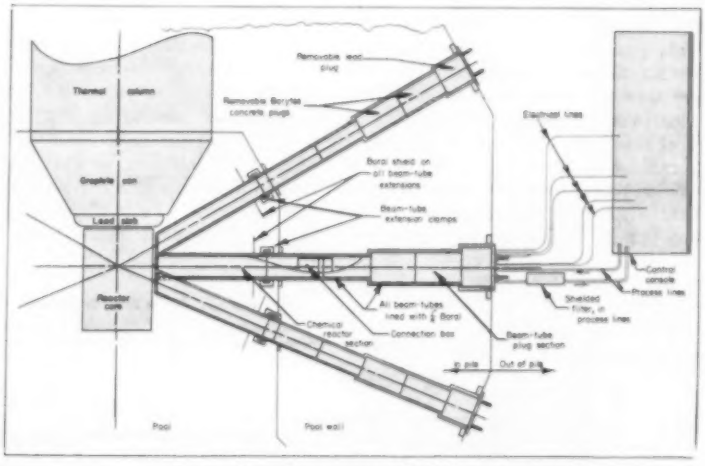


Fig. 9. General arrangement of equipment at Battelle.

Fig. 6. Fission energy absorbed in reactants as a function of the packing ratio, $\frac{V_f}{V_c}$

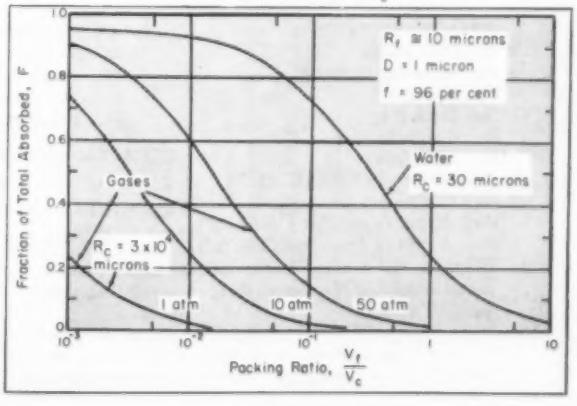


Table 2.

Duration of run (hr.)	Radiation dosage (r.)	Avg. m.p. of wax (° F.)	Avg. mol. wt.	Gas in reactor (%)	Avg. No. $-CH_2-$ groups /straight chain(*)	Avg. No. of bond fractures /molecule (**)
0	0	126	337		24.6	0.000
5	0	124	342	100 H_2	24.3	0.010
5	0	123.3	340	93 H_2, 7 N_2	24.2	0.017
5	0	123.0	339	93 H_2, 7 N_2	24.1	0.021
5	125,000	121.5	335	93 H_2, 7 N_2	23.8	0.034
5	125,000	122	337	93 H_2, 7 N_2	23.9	0.030
10.5	263,000	120.5	333	93 H_2, 7 N_2	23.6	0.042

* Calculated on assumption that original paraffin and products are mostly straight chains.
** Average number of bonds fractured per molecule, S

$$S = \frac{N_o}{N_n} - 1$$

where N_o = initial chain length in $-CH_2-$ units
N_n = final chain length in $-CH_2-$ units

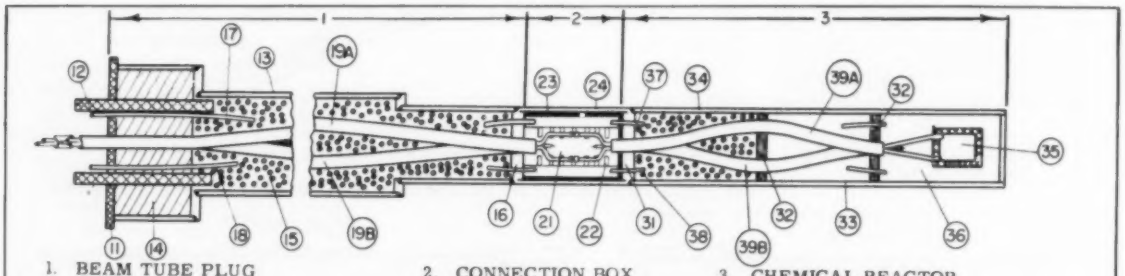
Chemical Reactions Promoted by Radiation

So far this discussion has considered the techniques of producing and using radiation. In this last section two specific applications of radiation chemical processing are discussed. In the first of these Henley, Karasyk, and Repetti (*5*) reported on the hydrogenation of high-molecular-weight alkanes and aromatics in the presence of gamma radiation. Their experiment consisted of charging a steel reaction vessel with a sample of paraffin wax (mol. wt. = 347, m.p. = 126° F.) and hydrogen under a pressure of 800 lb./sq. in. gauge. After appropriate testing for leaks, the vessel was heated to 550° F. and the pressure rose to 1,400 lb./sq.in. gauge. A cobalt-60 source was then moved into place so that the vessel was subjected to a radiation field of about 400,000 r./hr. It was estimated that 25,000 r./hr. penetrated the thick steel walls. Radiation runs were carried out for 5- and 10-hr. duration.

At the conclusion of the runs, the vessel was cooled, the hydrogen vented, and the wax sample removed. Analysis consisted of measuring the melting point of the wax in a small capillary tube. The molecular weight was calculated by means of a correlation with melting point. Table 2 presents the results of the experiments along with a calculation of the carbon-to-carbon bond fractures per molecule. The steady decrease in melting point and molecular weight with radiation dose is readily apparent. The authors call attention to the fact that the change in melting point is relatively small, however. They point out, though, that the radiation had a definite effect on the paraffin since the products had much wider melting ranges and exhibited strong gasoline odors that were not present in the original specimens. A reaction mechanism was suggested and an explanation given for the rather small amount of apparent bond cleavage.

Bray, Martin, and Anderson (*6*) reported on studies of the effect of gamma radiation on the polysulfone reactions of sulfur dioxide with the hydrocarbons, ethylene, propylene, butene-1, butene-2, isobutylene, hexene-1, decene-1, dodecene-1, 1-3 butadiene, and cyclopropane. One portion of the work was devoted to a study of the effects of radiation on the properties of the copolymer products, while a second portion involved a study of the kinetics of the reactions in the radiation field. Experimentally, the majority of the reactions were conducted in small batch reactors at a temperature of 0° C., at radiation intensities of 40 to 65 kilorep (roentgen equivalent, physical)/hr., and with approximately equimolar proportions of hydrocarbon to sulfur dioxide. Reaction times and radiation doses were varied for each of the reactions.

Fig. 10. Beam tube torpedo.



1. BEAM TUBE PLUG
   - 11. Face plate.
   - 12. Handling studs (4).
   - 13. Housing.
   - 14. Lead plug.
   - 15. Concrete plug.
   - 16. End plate.
   - 17. Electrical conduits (2).
   - 18. Thermocouple conduit.
   - 19a. Process conduit A (see "a").
   - 19b. Process conduit B (see "b").

2. CONNECTION BOX
   - 21. Support bar.
   - 22. Terminal lugs (28).
   - 23. Boral liner.
   - 24. Housing.

3. CHEMICAL REACTOR
   - 31. Face plate.
   - 32. Spacers (2).
   - 33. Housing.
   - 34. Concrete plug.
   - 35. Reaction vessel (1 or 2).
   - 36. Insulation.
   - 37. Electrical conduit.
   - 38. Thermocouple conduit.
   - 39a. Process conduit AR (see "c").
   - 39b. Process conduit BR (see "d").

ALUMINUM · TRANSITE · LEAD · BORAL · STEEL · BARYTES · SIL-O-CEL

a. Contains two process lines, tubular heater, and metal-sheathed thermocouples. Voids filled with bubbled alumina.

b. When one reaction vessel used, contains two tubes for carrying coolant. When two vessels used, contents same as Conduit A. Voids filled with alumina.

c. Contains two process lines and tubular heater. Voids filled with bubbled alumina.

d. When one reaction vessel used, contains two tubes for carrying coolant. When two vessels used, contents same as Conduit AR. Voids filled with bubbled alumina.

Melting or decomposition points, densities, and tensile strengths of the copolymers were measured and compared with those of the copolymers produced by other means as reported in the literature. In general the radiation polymer properties were higher. The values of the properties decreased with increasing molecular weight of the hydrocarbon reactant. Sulfur contents and solubilities in ordinary solvents were about the same as reported for the conventional polymers. Sulfur analyses showed that equimolar amounts of hydrocarbons and sulfur combined in the reactions. The copolymers from high-molecular-weight hydrocarbons were soluble in nonpolar solvents while those from low-molecular-weight hydrocarbons were soluble in polar solvents. Molecular weights determined by solution viscosity measurements were larger than for the conventional polymers.

In the case of the hexene-1—sulfur dioxide reaction, the temperature was varied from −77 to +46° C., the radiation intensity was varied from 3.6 to 987 kilorep/hr., and the initial proportion of hexene-1 to sulfur dioxide was varied from 0.187 to 5.69 in order to determine the specific effects of each of these variables. It was found that the reaction rate is proportional to the 0.76 power of the radiation intensity, and to the first power of the reactant concentrations for the high sulfur dioxide concentrations. At the lower temperatures the logarithm of the reaction rate constant varied linearly with the reciprocal of the absolute temperature. Near the "ceiling temperature" of 57° C. (above which reaction does not occur) and at high hydrocarbon concentrations the reaction rate varied irregularly with temperature, concentration, and radiation intensity.

Correlations of the kinetic data were obtained from expressions derived from a free radical reaction. According to this mechanism, the chain of reactions start by free radical initiation in the radiation field. This is followed by alternate addition to the reactant monomers and, finally, by radical termination. The final correlating equation proposed is

$$\frac{C_\beta}{C_{\beta i}} = \frac{1 - \dfrac{\beta}{C_{\beta i}}}{[\cosh \sqrt{k_1 k_2 I}\ \theta]^{k_3/k_2}} + \frac{\beta}{C_{\beta i}}$$

where C_β is the concentration of sulfur dioxide at any time θ, $C_{\beta i}$ is the initial concentration of sulfur dioxide, and the k's and β represent reaction rate constants for the intermediate steps in the mechanism. Figures 11 and 12 show how well this equation correlates the rate data for several different polysulfone reactions.

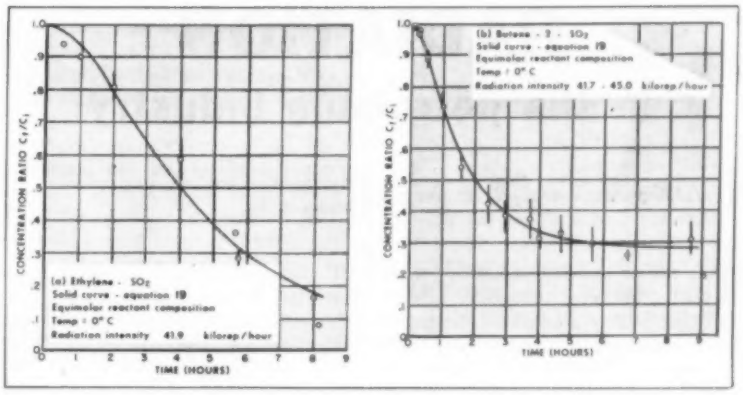

CONCENTRATION RATIO $C_\beta/C_{\beta i}$
TIME (HOURS)
(a) Ethylene - SO_2
Solid curve - equation 19
Equimolar reactant composition
Temp = 0° C
Radiation intensity 41.9 kilorep/hour
(b) Butene - 2 - SO_2
Solid curve - equation 19
Equimolar reactant composition
Temp = 0° C
Radiation intensity 41.7 - 45.0 kilorep/hour

Fig. 11. Concentration vs. time for some polysulfone reactions at 0° C., (a) ethylene-SO_2, (b) butene-2-SO_2.

Summary

This article has presented some of the most recent work in the field of radiation chemical processing. It is well known that there is a considerable amount of other research being conducted in the areas considered, particularly in the application of radiation to specific reactions. A number of companies have installed their own radiation laboratories or are sponsoring programs at industrial research laboratories. It is not expected that radiation processing will be accepted and widely used for some time because there is a fair amount of fundamental work that must be done first. However, it is not unrealistic to believe that products processed by radiation will be rather common within the next five or ten years.

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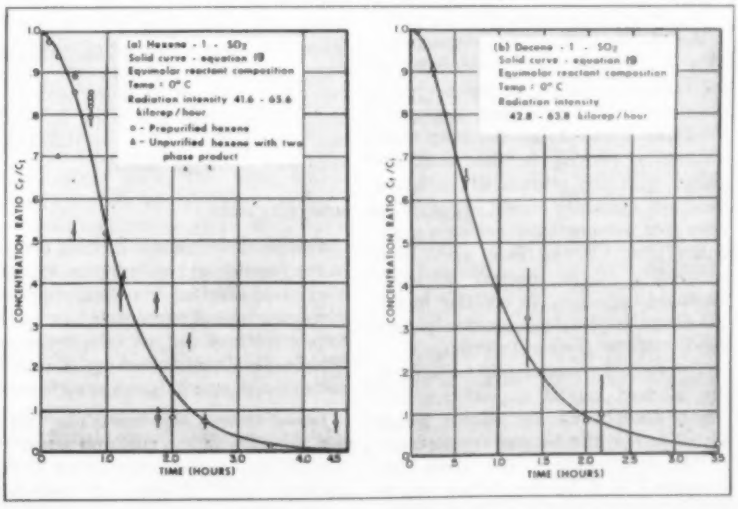
6. Bray, B. G., J. J. Martin, and L. C. Anderson, "The Effects of Gamma Radiation on Several Polysulfone Reactions," University of Michigan.

Papers presented at Chicago A.I.Ch.E. Meeting.

Fig. 12. Concentration vs. time for some polysulfone reactions at 0° C., (a) hexene-1-SO_2, (b) decene-1-SO_2.


CONCENTRATION RATIO $C_\beta/C_{\beta i}$
TIME (HOURS)
(a) Hexene - 1 - SO_2
Solid curve - equation 19
Equimolar reactant composition
Temp = 0° C
Radiation intensity 41.6 - 63.6 kilorep/hour
o - Prepurified hexene
Δ - Unpurified hexene with two phase product
(b) Decene - 1 - SO_2
Solid curve - equation 19
Equimolar reactant composition
Temp = 0° C
Radiation intensity 42.8 - 63.8 kilorep/hour

RADIATION
in the petroleum industry

T. J. Hardwick and R. P. Nejak | Gulf Research & Development Company, Pittsburgh, Pa.

The use of ionizing radiation for inducing chemical changes of interest is being widely studied by the petroleum industry. It would be preferable to present a concise and complete account of a specific research investigation. However, since the irradiation of petroleum derivatives is such a relatively new area of investigation and one which is more complicated than expected, this article will by necessity be in the nature of a progress report. Reference will be made to a number of projects, mostly still in the development stage, rather than specific projects of interest singled out for full report. A selection of published experimental results will indicate the general area of interest to the petroleum industry.

Broadly speaking, the petroleum industry is applying radiation energy in the research and development of refinery processes, petrochemicals, and radiation resistant products. All major oil companies have research programs in one or more of these fields.

Up to the present time no startling discoveries have been reported, and the general feeling is that no immediate profit is to be made from the use of ionizing radiation. Notwithstanding this lack of short-term gains, however, most companies feel that there will eventually be a use for radiation in some phase of processing, and are carrying out basic research with this expectancy in mind.

There are many avenues of approach to the problem of utilizing radiation. This is perhaps best illustrated by the variety of radiation sources used throughout the petroleum industry. In Table 1 are listed the major oil companies working in this field, together with the sources of radiation they are currently using. It will be seen that some groups prefer γ-rays, either from Co^{60} or from spent fuel elements; others prefer machine-produced radiation. In addition to the facilities listed, some companies are using nuclear reactor facilities.

The radiation source selected reflects the allowed capital expenditure and the philosophy of use. Some people visualize that the nuclear reactor and/or its by-products (Co^{60}, spent fuel elements) will be the future source of cheap radiation. In using these facilities for research these groups are obtaining experience which they consider will be helpful in future industrial applications. Others feel that machine-produced radiation is better for experimentation. Machines have versatility, a high output, an on-off feature, and possible commercial use. A third group has effected a compromise and is actually using both types of sources.

Developmental Research

RADIATION RESISTANCE

A problem of increasing importance in the industry is the effect of radiation on standard petroleum products. A case in point concerns the use of lubricants which in normal operation are exposed to a field of radiation. Unfortunately most commonly used lubricants are adversely affected under such conditions. At doses above 10^7 roentgens mineral base oils increase in viscosity; greases either soften or harden, depending on composition; ester base lubricants produce corrosive acidic products. All form some light hydrocarbons.

The demand for radiation resistant materials is not for use in nuclear power plants, for there the total exposure of lubricants will generally be low. In certain cases, however—such as in atomic powered aircraft—lubricants, hydraulic liquids, etc. will be required to operate in high radiation fields. A new class of lubricants, tailored to meet a new set of specifications are under development. Most formulations have included aromatic compounds, which are found to "protect" the bulk of the material from excessive radiation damage.

NEW PROCESSES

Considerable interest is being shown in the possible use of radiation to augment or supplant existing refinery processes. Studies reported to date have concerned the use of a radiation field on the thermal cracking of hydrocarbons and on catalytic isomerization.

Thermal Cracking Experiments: The thermal cracking of gas oils and pure hydrocarbons has been carried out in the presence and absence of radiation fields. It was found that radiation promoted a slight increase in product yield. The onset of cracking occurred at lower temperatures in the presence of radiation. In all cases the product spectrum was not greatly changed.

Catalytic Isomerization Experiments: Preliminary experiments on the isomerization of pentane absorbed on various catalysts have shown that the isomer yield is increased in the presence of a radiation field. It appears that this phenomenon is found only on certain catalysts, and is most pronounced when the catalysts are in a fine state of subdivision.

PETROCHEMICALS

Another field of investigation has been the radiation-induced polymerization of vinyl monomers. Most polymerization reactions which proceed by a free radical mechanism can be initiated readily by ionizing radiation. Although the use of radiation must compete with other methods of initiating polymerization, such as by catalysts or by heat, ionizing radiation has two distinct advantages. Radiation is an external initiator, thus contamination by the catalyst is not a problem. Polymerization may be made at low temperature, in fact, even with the monomer in the solid state.

As a specific example of direct application to lubricant problems, it was found possible to produce polymers suitable as pour depressant and viscosity index improver additives through radiation-initiated polymerization of unsaturated esters.

Radiation has a considerable effect on the structure of solid organic polymers. In a radiation field a solid polymer will tend either to degrade or crosslink. Degradation arises from a radiation-induced scission of a carbon-carbon bond in the polymer molecule. The resulting fragments are of lower molecular weight. Polymers so degraded show decreased dielectric strength, lower tensile strength, and a poorer resistance to swelling in solvents.

Crosslinking arises from the radiation-induced scission of carbon-hydrogen bonds in adjacent polymer molecules. The large fragments combine, forming a chemical bond. In such a manner a three-dimensional structure is built up.

Such crosslinking is of commercial importance in the case of polyethylene. As a result of absorbing radiation, this polymer has better structural rigidity at high temperatures and a decreased tendency to swell in common solvents.

The preceding examples illustrate

the scope of developmental research which is now being carried out. Each petroleum company has a large backlog of information on irradiation of standard petroleum products and refinery fractions. As of now, little has been published on this phase of research.

Fundamental Research

In spite of the availability of substantial amount of data on the radiolysis of hydrocarbons, very little is known of the mechanisms of the reactions. There are, however, several generalizations which can be made. For example, aromatic hydrocarbons are more stable to radiation than paraffins, and unsaturated compounds are produced from saturated ones. However, the detailed mechanisms of such processes are not known. Take, for instance, a simple hydrocarbon such as normal hexane, which has five carbon-carbon bonds and fourteen carbon-hydrogen bonds. On radiolysis any one of these bonds may, and does, break, leaving a variety of fragments. These fragments which are mostly free radicals may react in any combination by addition, to give a new paraffin, or by disproportionation to give a paraffin plus an olefin. In this particular case we are left with a mixture of hydrocarbons from methane to C_{12}. Once having solved the analytical problem (a feat in itself), we are confronted with the difficulty of determining from these data the relative amounts of the primary fragments.

A second approach to this problem of identifying the primary radicals has been to add to the hydrocarbon a substance which will react with and scavenge all the radicals formed in the primary process. This technique has been successful using dissolved iodine as a scavenger. The resultant products are alkyl iodides which may be identified and estimated quantitatively. Although there is some question as to the interpretation of such results, a pattern of the behavior in the case of saturated aliphatic hydrocarbons is beginning to emerge. It is found, for instance, that in a paraffin a tertiary carbon-hydrogen bond is most likely to break. This is followed in probability by a secondary carbon-hydrogen bond, a carbon-carbon bond, and a primary carbon-hydrogen bond, in that order. When there are branched chain hydrocarbons, chain scission is most likely to occur at the carbon-carbon bond adjacent to the side chain. The probability of a terminal carbon-carbon bond cleavage is quite low.

Ionizing radiation has one unique feature which sets it apart from thermal methods of supplying energy—*the effective temperature of one molecule can be raised without affecting its neighbors.* This results in the fragments being quickly "cooled" to the temperature of the system. These fragments, or radicals, are often thermally stable at room temperature and thus will persist until removed by reaction with a scavenger or with another radical. Take an example, normal hexane. On heating to 450° C., cracking occurs, but any hexyl radicals formed immediately decompose into smaller radicals and an olefin. On radiolysis at room temperature, however, the hexyl radical is relatively quite stable. As a result we find in our products a relatively high proportion of dodecane isomers. This phenomenon of dimerization is quite general. Radiolysis of liquid butane gives a high yield of mixed octanes; under the same conditions pentane produces mostly decanes.

Aromatic hydrocarbons have considerably more resistance to decomposition by radiation than do saturated hydrocarbons. Not only are they more stable in themselves, but small concentrations of aromatics present in paraffin systems decrease the total decomposition out of all proportion to their concentration. This "protective effect," as it is called, arises from the ability of the aromatic molecules to remove energy by collision from excited aliphatic molecules which would otherwise decompose. The resonant nature of the aromatic molecule allows this energy to be spread out over the entire molecule. This energy is subsequently removed by fluorescence or by deactivating collisions. The detailed processes of this energy transfer are still quite speculative, and much work remains to be done before a satisfactory explanation can be found.

Economic Considerations

When experiments are directed towards the development of an industrial process utilizing radiation, costs become a formidable problem. As matters stand now, the most optimistic evaluation of process costs for nonchain reactions is about five dollars a pound. Since any such process is usually competing with other methods of production, the future of radiation in the petroleum industry would seem to be dim.

There is, however, reason for optimism. The first is that the cost of radiation is decreasing. Machines producing ionizing radiation are becoming more powerful, with a consequent reduction in cost per installed kilowatt. The price of Co^{60} is decreasing, and

according to estimates of the AEC may eventually be but 2 to 5 per cent of the present cost. The availability and handling expense of spent fuel elements make such sources rather costly at the present time, but there is every reason to expect that both situations will improve with time.

In view of this future in which the cost of radiation will be less, it is quite likely that today's uneconomic process may be profitable tomorrow. It is realized by those working in this field that tremendous problems exist in bringing any radiation-induced process to a production stage, but this valuable experience must be gained firsthand.

Obviously the most fruitful field is that of petrochemicals, where the cost of many specialized products is high, and radiation processes will be able to compete in the near rather than in the distant future.

The petroleum industry considers that there is a future in the use of ionizing radiation and all of the major firms have active research programs in this field. The industry is looking for a break-through in the cost of radiation, and when this happens, it will be an eager customer.

Presented at the Annual Meeting of the Atomic Industrial Forum, New York City, October, 1957.

Table 1.—Radiation sources used by petroleum companies.

Company	Sources
Atlantic Refining	1 Mev resonant transformer
Cities Service	6000 curies Co^{60}
Continental Oil	Co^{60} — 10^6 r/hr. Spent fuel elements
Esso Research & Eng.	3500 curies Co^{60}
Gulf Research & Devel.	3 Mev Van de Graaff
Humble Oil & Refining	2 Mev Van de Graaff
Magnolia Petroleum	0.5 Mev Van de Graaff 2 Mev Van de Graaff
Shell Development	2 Mev Van de Graaff 3 Mev Van de Graaff
Sinclair Oil	Spent fuel elements
Socony-Mobil Oil	2 Mev Van de Graaff (planned) Spent fuel elements
Standard of California	2 Mev Van de Graaff Co^{60} source — 2×10^5 r/hr.
Standard of Indiana	3 Mev Van de Graaff (planned)
Texas	6 Mev linear accelerator (planned) 3 Mev Van de Graaff 35,000 curies Co^{60}

NUCLEAR PROCESS HEAT REACTORS —

A large potential market exists for the application of nuclear heat to the process industries. Existing technology with minor improvements could produce low pressure steam competitive with fossil fuel. The application of nuclear reactors to chemical and metallurgical processing involves a large number of problems, depending upon the specific system proposed. Designs will be compromises between the optimum nuclear, thermodynamic, metallurgical, and size factors.

Bernard W. Gamson | Borg-Warner Corporation, Des Plaines, Illinois

Emphasis on the utilization of nuclear energy in the period following World War II has been focused principally on the development of reactors for propulsion of naval vessels or for land-based large central station power plants. Little effort, other than paper studies, has been devoted to the use of reactors for process heat in its broadest definition. This has resulted because of the urgency of the Naval Reactor program from tactical and defense considerations (where costs are relatively meaningless) and the effort to utilize the technology of the Naval Reactor program and other low temperature reactor types for developing commercial power plants.

In the basic fission process, the energy release is evidenced overwhelmingly as heat—the form in which it is ultimately desired to be used for chemical process purposes. Furthermore, the nuclear reactor is not limited to any arbitrary temperature level comparable to a theoretical flame temperature as in an exothermic chemical reaction. The operating temperature is only limited by materials of construction. It is possible to operate at high pressures with minimum costs because of the lack of compression of inert constituents.

In contrast to electrical power needs, the use of a reactor for process purposes minimizes the capital cost for a given energy output since it eliminates secondary power generation equipment and the thermodynamic and mechanical inefficiencies of a multistage energy system. The thermal kilowatt output may be three to four times the equivalent electrical kilowatt capacity for a given reactor size. Chemical reactions carried out in nuclear reactors can show a maximum thermal efficiency and (potentially) significantly lower capital and operating costs because there are no gaseous combustion products evolved and stack energy losses are eliminated.

Several studies (*9*) (*10*) have evaluated the potential market for non-electrical energy. Of the total energy consumption in the United States, less than 15 per cent is used in the form of electrical energy. Space heating and transportation account for the largest single users. It appears doubtful if any significant usage inroads on these two energy requirements can be made with current nuclear technology. Following the uses above in importance are process heat applications in such basic industries as petroleum, chemicals, pulp and paper, cement, glass, textile fibers, rubber products, and virtually the entire spectrum of our industrial economy.

Figure 1 illustrates the pattern of growth projected for process heat in the United States from 1955 to 1980. It also shows the latest forecasts of Davis and Roddis (*4*) for the total electrical generating capacity throughout this period. The relatively parallel growth between electrical capacity and process heat requirements is striking as well as the approximate order of magnitude of the absolute energy requirements based upon the McKinney forecast. This shows the huge market for process heat as well as for electrical energy and illustrates the potential for the nuclear industry in an area which has been neglected. The lack of development effort associated with process reactors has probably been influenced by the recognition that many of the problems associated with practical economic units must first be solved for electric power generation.

Use of Process Heat

There are several distinctive features in the process heat market. Heat energy is generated at the site of utilization and is very seldom transported beyond battery limits. There are, in general, two basic types of process heat requirements: first, the use of either high or low pressure steam for process heating, and second, the use of process heat for preheating reactants to a temperature where the reaction kinetics will permit a chemical reaction to take place or to supply an endothermic heat of reaction.

CHEMICAL

In general, the desired energy for promoting chemical reactions requires operation at temperatures beyond that of the highest steam pressures and temperatures in use today. It is precisely in these high temperature areas that nuclear heat may show marked process and cost savings over conventional combustion processes or electrical energy either to develop high temperatures *per se* (such as in ferroalloy operations) or to overcome an unfavorable low-temperature free energy change in a chemical reaction.

Thus, the blast furnace for iron ore reduction is the largest single user of industrial carbon (to the extent of approximately 120 million tons per year), and of this amount approximately 70 per cent is required for the combustion process to preheat the iron ore, slag additives, and remaining carbon in order to reach a temperature where the reduction proceeds, and in the sensible heat of the stack gases, slag, and metal. The balance is required for reducing the iron oxide to pig and for carburization to the desired carbon level. Another example is the use of electrical energy for the reduction of aluminum oxide in the Hall process, which is carried out at a temperature of approximately 1,700° F. This requires electrical energy of about 8 to 10 kw.-hr./lb. of aluminum produced and necessitates the use of a large multitude of cells in parallel, each producing usually less than 500 lb. of aluminum/day. The thermodynamics of the aluminum production process are such that the free energy becomes favorable for a direct thermal reduction with carbon at temperatures of approximately 3,500 to 4,000° F. It is possible to conceive of a nuclear reactor which operates at this temperature with substantially known materials of construction and capable of producing large quantities of aluminum in a direct operation in a single reactor comparable to a blast furnace with molten aluminum as the primary product and carbon monoxide as a by-product.

Figure 2 shows the use of a nuclear reactor for the thermal fixation of nitrogen based on the Wisconsin process (*12*), which has had considerable development by Food Machinery and Chemical Corporation at Sunflower Ordnance Works, Lawrence, Kansas. The thermal fixation process, as practiced in the past, has had high operat-

— problems large, rewards great

ing costs and fuel costs. A successful process for the thermal fixation of nitrogen could have both local and worldwide impact on the availability of cheap fertilizers and nitrogen chemicals. Nuclear process heat utilized solely for the high temperature region coupled with recuperative heat could be a unique and perhaps final answer to universal inexpensive nitrogen fixation. The thermodynamics of the reaction are such that an endothermic energy of 38,800 B.t.u./lb. mole of nitric oxide is required and at temperatures of approximately 4,000° F. about 2½ per cent of nitric oxide is formed. In order to inhibit the thermal decomposition of the nitric oxide, it is necessary to chill the high temperature gas stream at the rate of 30,000° F./sec.

The use of a nuclear process flow as shown above would eliminate the need of a fixation plant using expensive fuel and would minimize the size and capital costs of the regenerative furnace for quenching the reacted air stream. Such a unit could be installed anywhere in the world and would not be dependent on heavy charges for freight, raw materials, or fuel.

Figure 3 shows a schematic process flow diagram of an indirect nuclear reactor for use in the gasification of coal with steam or oxygen operating at a temperature of about 2,500° F. The AEC, in conjunction with the Bureau of Mines, is sponsoring a study for the application of nuclear process heat to this system. By the judicious choice of the indirect cycle, Dalzell and McGee (*1*) have shown that it may be possible, with current technology and with a moderate development effort, to build a plant for this operation in a minimum period of time. Such a plant is predicated upon circulating helium gas through a pebble bed reactor, exchanging the hot helium stream with the vaporized and preheated coal-water mixture through a countercurrent heat exchange system which minimizes the size of the high temperature heat exchanger.

Helium was chosen as the inert gas because of its over-all superior properties as compared to other possible contenders such as argon, carbon dioxide, hydrogen, and nitrogen. Table 1 summarizes the pertinent physical, chemical, and nuclear properties of these materials. The authors (*1*) give the results of a parameter study for a reactor of a thermal loading of 250 megawatts and a pressure of 30 atmospheres. Their recommended design requires 3-inch spherical elements, bed depth of 10 feet, and a bed 12 feet in diameter.

De Felice (*5*) describes a high

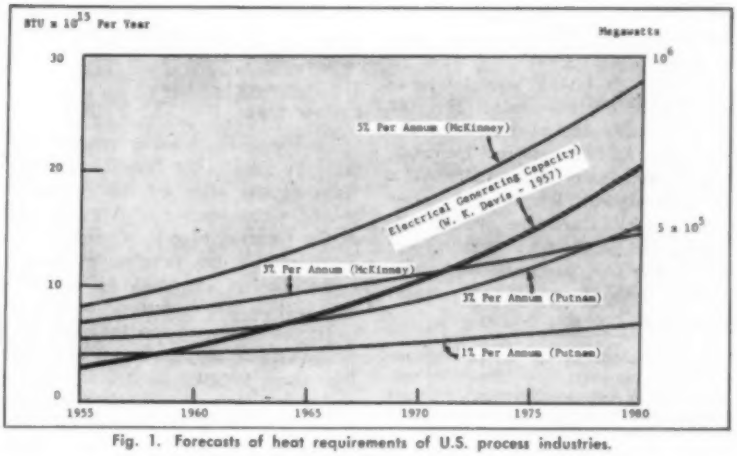


Fig. 1. Forecasts of heat requirements of U.S. process industries.

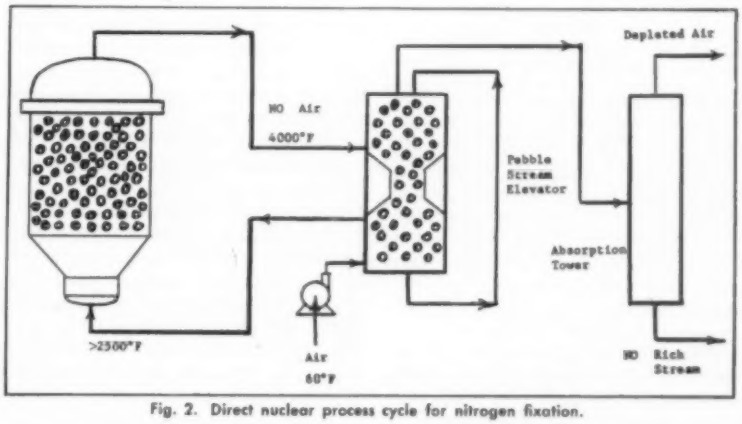
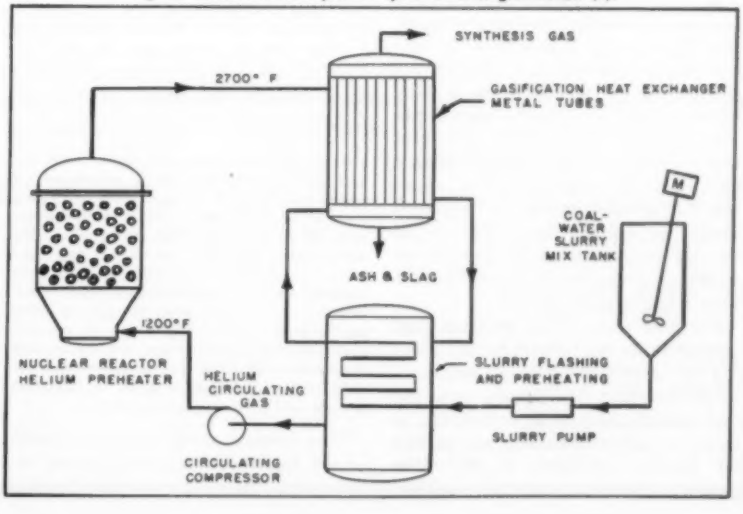


Fig. 2. Direct nuclear process cycle for nitrogen fixation.

Fig. 3. Indirect nuclear process cycle for coal gasification (*1*).



operating temperature reactor design which could be used as a critical component test reactor and which can be built immediately. It employs two separate power producing regions. An inner high temperature region uses helium as a coolant with a maximum temperature of 2,500° F., and an outer low temperature region using water as a coolant with 170° F. exit temperature. This concept concentrates the major development problems in the preparation of hot zone fuel elements, since the remainder of the reactor is a conventional low temperature water system. It eliminates the necessity of bridging the gap between existing low temperature and proposed high temperature technology in one major break-through plant.

Several features of the design are noteworthy. It appears safer than the one-region design because all control rods are in the lower temperature region since a dependable control rod operation at 2,500° F. has not yet been developed. The low temperature fuel elements are similar to the MTR in geometry and composition. The high temperature zone is flexible and can evaluate different fuel element geometries, fuel meat, and cladding. Davidson and Strasser (*3*) review the process application and material problems for the two-region reactor. A review is given of possible fuel and cladding materials as well as listing many possible chemical processes which could be potential candidates for evaluation of a reactor in the 2,000-3,000° F. range. These include the production of acetylene by the Wulff process, HCN from methane and ammonia, ferro-alloys, and elements such as sodium, magnesium, graphite, and phosphorus.

STEAM

The second major use for process heat is in low or high pressure steam for process heating. Virtually all such energy is generated *in situ* at the plant site where employed. Today most process steam plants use coal as a fuel. Oil and gas are attractive for this purpose and give rise to lower capital costs than would a comparable coal-fired plant. However, the rapidly rising cost of oil and gas necessitates realistic planning of fossil steam plants based on coal. The trend of fuel costs even for coal is on the increase. Heavy fuel oil at 10¢ a gallon gives a fuel cost for process steam of approximately 70¢/million B.t.u. This is in contrast to current total generating charges of probably 50¢ to 65¢/million B.t.u. when burning coal.

The cost picture for uranium fuel appears to be markedly different from that for fossil fuels. Present fuel costs should decrease significantly over the next decade, and it is reasonable to expect a cost of $10.00/gram or less for highly enriched U-235. The amount of uranium currently available is so large that the AEC has curtailed new purchases for a significant period. In general, process steam usage shows the same demand requirements as electrical energy, and industry uses for steam require capacities of 100,000 to 200,000 lb./hr./unit comparable to a reactor in the 30 to 60 megawatt heat range.

Reactor Types

The pressurized water reactor successfully used in the Nautilus and the Shippingport plant or the successful boiling water reactor of Argonne and of the General Electric Company are both suitable for developing process steam. In fact, the actual operation of both boiling water reactors has proved so successful that it appears likely that power outputs may be raised to two to four times design capacity. This illustrates the tremendous developments which are likely to take place once operating experience has been achieved, resulting in reduced capital and operating costs.

Heller and Hubbard (*6*) have described a pressurized water reactor for low pressure steam and have compared the capital and operating costs of such a nuclear plant with that of fossil fuel steam plants. The PWR is based upon a reactor core of fully enriched U-235 lasting about six months with a 30 per cent burn-up and a blanket of natural uranium oxide with a life of about 5,000 megawatt days/ton. Aluminum or aluminum nickel alloy cladding is used for the fuel elements. The use of the blanket permits producing as much heat in the blanket as is produced in the core. Based on existing knowledge, it would appear possible to produce 800 lb./sq.in. water at 450° F. in such a reactor with 150 lb./sq.in. steam in conventional U-tube heat exchangers.

Figure 4 shows typical curves developed by Heller and Hubbard (*6*) for the cost of steam as a function of coal and oil cost for plants containing three boilers each and a capacity of 220,000 lb./hr./unit.

By comparison, estimated capital cost for a 220,000 lb./hr. reactor is developed at approximately $2¼ million, with operating costs of $815,000/year, giving reactor steam costs at 95 per cent load factor of 44.5¢/million B.t.u. and 49.8¢ at 85 per cent load factor. These costs are predicated upon what appears to be realistic amortization rates, fuel costs, labor, and other charges. In other words, with current technology it appears probable that process steam may be already competitive with fossil fuel for commercial size units and at fuel costs of $7.00 to $8.00/ton of coal and 5¢ to 6¢/gallon of oil.

The current status of development of the high operating temperature reactors for chemical processing is of a much less well-defined nature. Furthermore, the design problems are associated with the specific type of chemical process that one visualizes applying to the nuclear reactor. Thus, the choice of fuel element, cladding, moderators, coolants, control rods, and other fundamental nuclear parameters are markedly influenced by the nature of the process stream—whether it is oxidizing, reducing, or inert chemically in addition to the nuclear properties. The purity of raw materials becomes very critical because of induced radioactivity in the product as well as effects on the neutron economy.

There are three basic types of reactors which can be considered for chemical processing. These are the direct cycle, indirect cycle, and process stream preheating. In the direct cycle all of the process streams pass through and react within the reactor proper. In the indirect cycle an inert gas such as helium, nitrogen, or carbon dioxide is heated in the reactor and heat exchanged with the process streams in an external heat exchanger. The process stream preheat has one of the reactants preheated in the nuclear reactor and then mixed with the other reactants in a separate reaction vessel. Depending upon the nature of the reaction, any one type may show marked superiority to the others. The indirect cycle reactor appears to offer a minimum development effort for high temperature processing since helium (which is inert chemically and nuclearly) can be used. Daniels (*2*) proposed a gas turbine cycle equally adaptable to process steam or electrical energy development.

The high temperature reactor design is complicated not only by the chemical and engineering problems, but is affected by the relative changes with increased temperature in nuclear properties of the fuel, moderator, poison, control materials, and coolants. This necessitates a reevaluation of the start-up, operation, safety, and shutdown behavior of these reactors compared to conventional power types operating in the 400 to 1,000° F. range.

Fuel element design should have cladding with low neutron absorption cross sections, mechanical strength to resist thermal stress, contain fission products, and resist abrasion and erosion by coolant flow and temperature cycling. It should show dimensional integrity under high burn-ups, have high thermal conductivity, ease of fabrication and reprocessing, and low costs. Where gaseous streams are processed, the most favored fuel element geometry has been the sphere. It combines a large heat transfer sur-

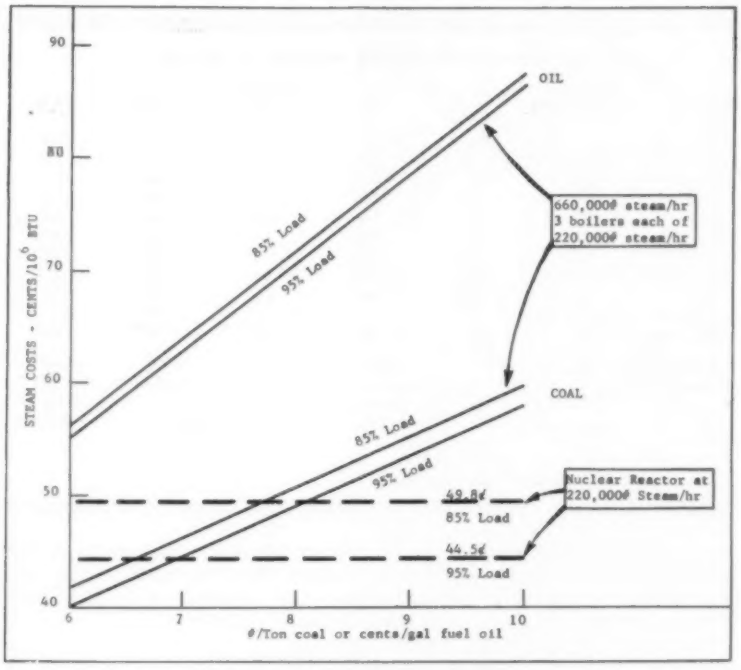


Fig. 4. Cost comparison of fossil and nuclear steam (6).

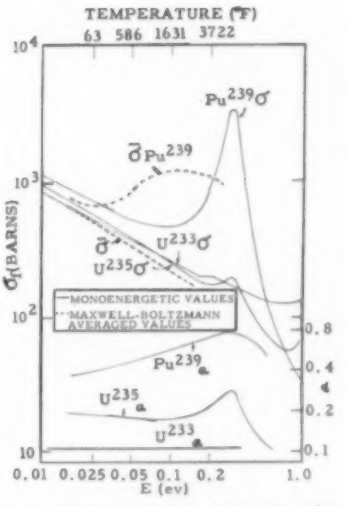


Fig. 5. Temperature dependence of nuclear fuels (11).

face per unit reactor volume, self-support, and ease of loading and discharging spent fuel. In addition, heat, mass, and momentum transfer phenomena are available for this geometrical configuration.

Daniels (2) has proposed a fuel element of uranium carbide with graphite in sealed graphite tubes for operation as high as 3,600° F. Spherical elements consisting of an inner graphite core, a fuel layer of uranium carbide, and a protective coating of a ceramic or cermet such as silicon carbide are possible. Other possible fuel materials are uranium oxide, nitride, sulfide, and intermetallic compounds such as the silicide. The fuel element clad will depend primarily on the chemical nature of the coolant stream and secondarily on the temperature, with graphite and niobium favored for helium; molybdenum, graphite, and the refractory intermetallic compounds of NiAl, CrAl and $ZrAl_2$ for hydrogen and hydrocarbons; aluminum oxide and NiAl, CrAl, and $ZrAl_2$ for air; and silicon carbide and aluminum oxide with water gas.

Figure 5 (7, 8, 11) shows the temperature dependence of the fission cross section σ_f, and the ratio of parasitic capture cross section to fission cross section α, for the three fissionable fuels Pu-239, U-235, and U-233 as a function of monoenergetic neutron energy from 0.01 to 1 ev.* The high value of α for plutonium through the entire high temperature spectrum up to where any solid can exist (<8,000° F.) as well as the peak in fission cross section probably precludes its use as fuel material. The low values of σ_f at elevated temperatures for U-235 and U-233 mean that the critical mass for chemical process reactors will probably be higher than for power reactors and that the thermal reactor is most desirable from the standpoint of minimum critical mass. A large amount of reactivity control will be required because of room temperature assembly. The presence of fertile material will be useful in reactivity control since high resonances above about 6 and 20 ev. for U-238 and Th-232 exist.

Figure 6 (7, 8, 11) shows the absorption cross section change in fission product poisons Xe-135 and Sm-149

* In addition, the Maxwell-Boltzmann averaged neutron cross sections (σ'_f) for U-235 and Pu-239 are shown.

Table 1.—Properties of High Temperature Coolants (1)

Gas	Mol. wt.	Spec. vol. at STP—cu.ft./lb.	Spec. heat at 2,500° F. Btu/lb.—° F.	Nuclear properties Thermal absorption cross section σ_a	Comments	Chemical properties
Argon	40	9.5	0.12	0.62	Forms radioactive argon 41	Inert
Carbon dioxide	44	8.5	0.34	0.003		Reacts with graphite at elevated temperatures
Helium	4	95.2	1.24	0.007	Inert	Inert
Hydrogen	2	187.9	3.94	0.32		Reacts with graphite. At high temperatures reaction decreases. Forms hydrides with many metals.
Nitrogen	28	13.5	0.29	1.7	Forms radioactive carbon 14	Reacts with many metals at high temperatures.

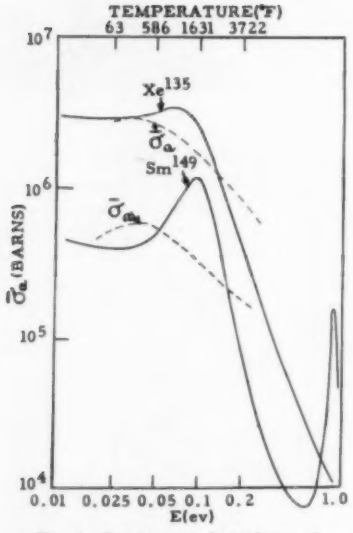


Fig. 6. Temperature dependence of poisons (11).

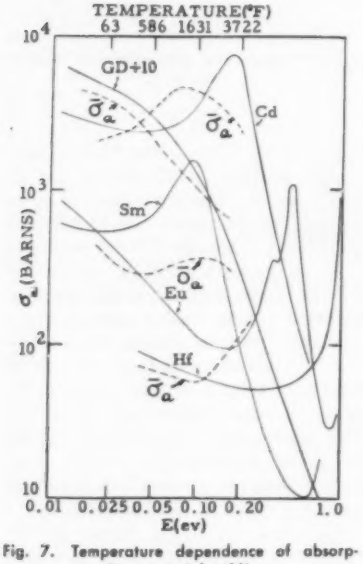


Fig. 7. Temperature dependence of absorption materials (11).

as a function of monoenergetic level and Maxwell-Boltzmann averaged values. The rapid decrease with temperature at high temperatures would add a positive temperature coefficient of reactivity, and the maximum in the Sm-149 cross section causes a reactivity barrier during start-up or shutdown of the reactor.

Figure 7 (7, 8, 11) shows several materials which are potentially usable as burnable poisons or for control rods and available in high temperature form as oxides, carbides, or nitrides. Use of materials (such as hafnium) which have large resonances above 1 ev. is interesting. Where gases are used as coolants, it may be necessary to use reservoirs of BF_3 or other

Table 2.—Moderator Comparison According to Roberts (11)

Material	Density—60° F.	Σ_a	Σ_s	Property $\xi\Sigma_s$	$\Sigma_a/\xi\Sigma_s$	$D/\xi\Sigma_s$
H_2O	1	710	1.1	6.1	860	3.8
D_2O	1.1	1	1.5	7.3	1	1.9
Be	1.7	37	3.0	5.9	46	1
Be_2C	3.0	24	3.1	5.0	35	1.1
BeO	1.9	28	2.8	5.0	42	1.3
C	2.2	12	2.3	3.4	25	2.2
MgO	3.6	110	1.7	1.6	500	6.2
Al_2O_3	4.0	320	1.5	1.4	1700	9.3
SiC	3.2	200	1.5	1.8	850	6.9
SiO_2	2.3	96	1	1	700	17
ZrO_2	5.7	160	1.7	1.2	990*	8.5
Property desired		small	large	large	small	small
Minimizes		losses by moderator absorption	leakage of thermal neutrons	absorption during slowdown	absorption in moderator during slowdown	leakage during slowdown

* plus contribution from resonance captures in Zr.

poisons to spike the reactor during excursions. It should be possible, for a given reactor operating temperature, to choose the fuel, fertile, and poison materials in such a way that the reactor would have a low temperature coefficient of reactivity to just below the design temperature and a large negative coefficient above design temperature to reduce the danger of runaway surges. Roberts (11) discusses the detailed effects of nuclear properties of these materials on reactor design.

The type of moderator used will depend upon the nature of the chemical reaction. Liquid moderators such as water and hydrocarbons are rejected unless used in low temperature reflectors. Roberts has evaluated the relative moderating properties of a group of potential high temperature materials compared with common moderators such as water and carbon. Table 2 summarizes his normalized data. These relations emphasize the complexity of the final choice of key nuclear, chemical, metallurgical, and structural materials to yield a safe operating reactor.

Acknowledgment

The author gratefully acknowledges the encouragement of L. Griffis and Borg-Warner Corporation Management in the preparation of this material.

Notation

- σ = microscopic neutron cross section, barns
- σ' = Maxwell-Boltzmann average microscopic neutron cross section (this appears as a sigma with bar over it in Figs. 5, 6 and 7).
- Σ = macroscopic neutron cross section
- ξ = average logarithmic energy decrement per collision for a neutron slowing down
- D = neutron diffusion coefficient
- α = ratio of parasitic captures to fission captures in fissionable material

Subscripts

- f = fission
- a = absorption
- s = scattering

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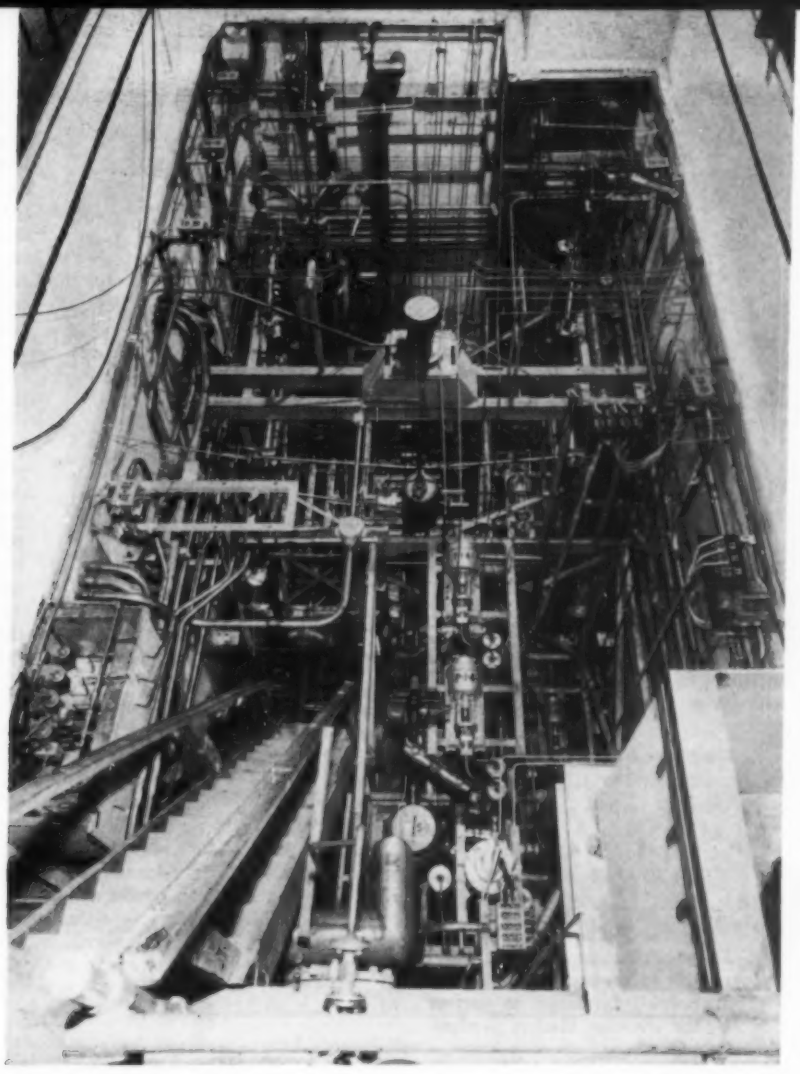


Fig. 2. Photograph of processing cell from north.

high radiation level

HYDROCLONE CENTRIFUGING removes homogeneous reactor fission products

W. D. Burch | Oak Ridge National Laboratory, Oak Ridge, Tennessee

Insoluble corrosion and fission products are shown to be effectively removed by centrifugal separation in a hydraulic cyclone operated at reactor temperature and pressure. These insolubles comprise all corrosion products except nickel and approximately 70 per cent of the fission products. A weekly batch purge of the recovered solids with 2 per cent of the fuel solution keeps in balance the soluble fission and corrosion products. Over 1,000 hours of nonradioactive operation of the hydroclone system have demonstrated operability and established performance characteristics of the system. Data preliminary to radioactive operation, scheduled to begin about January 1, 1958, are reported.

One of the major advantages of a homogeneous reactor system for power production is the potentially low fuel cost due to inherently simple processing schemes. Elimination of fuel element fabrication and dissolution prior to processing acts to reduce costs materially. A pilot plant has been constructed in cells adjacent to the Homogeneous Reactor Test to develop the processes to exploit these advantages. In this processing plant the enriched uranyl sulfate fuel is continuously purified by centrifugal separation of insoluble fission and corrosion product poisons.

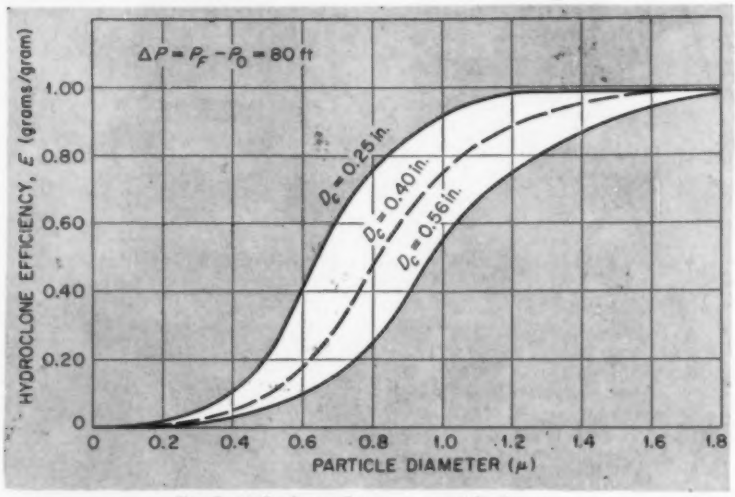


Fig. 5. Hydroclone efficiency vs. particle diameter.

The steps in processing the core solution of a homogeneous reactor system, as presently envisioned, are as follows:

1. Continuous removal of insoluble fission and corrosion products via hydroclones.
2. Batch letdown of solids removed with sufficient fuel solution to purge soluble poisons.
3. Recovery of D_2O from uranium and solids.
4. Decontamination of uranium and recycle to reactor via either:
   a. Solvent extraction as part of the thorium blanket processing.
   b. Peroxide precipitation after H_2O leaching of the solids.

Only the first three processing steps are included in the present plant. Complete dissolution of recovered solids is incorporated prior to Step 4 in order to permit a more complete evaluation of the first two steps.

Flowsheet Description

While the plant has been described in detail previously (*1*) a brief review of the flowsheet (Fig. 1) will help clarify the material presented. A 0.75 gal./min. bypass stream from the reactor fuel system at 280° C. and 1700 lb./sq. in. is circulated through the high-pressure system consisting of a heater to make up heat losses, a screen to protect the hydroclone from plugging, the hydroclone and related underflow receiver, and a canned motor circulating pump to make up pressure losses across the system. The hydroclone is operated with an underflow receiver which is drained periodically at a time when the processing plant has been isolated from the reactor system. Present plans are to operate on a weekly cycle.

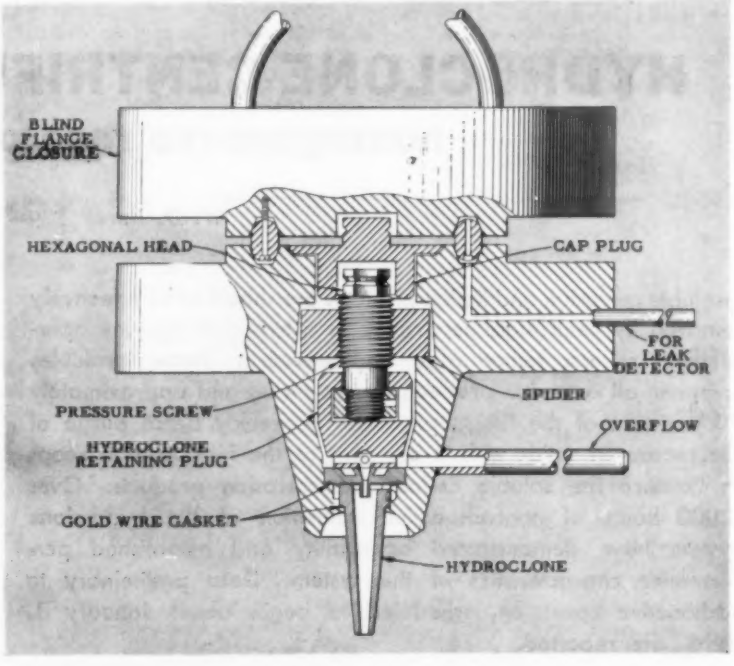
At the conclusion of each operating period with the reactor, a "slurry" sample of the underflow pot contents is taken for later comparison with solution samples. Approximately 10 liters (2 per cent of the reactor fuel) is drained to a 5-gal. vessel where heavy water is evaporated and recovered prior to dissolution of the solids in a light water sulfuric acid system. By utilizing a combined concentrated acid reflux followed by 4-molar refluxing, complete dissolution of all solids is obtained. After sampling, the solution is pressured to one of two 100-gal. decay storage tanks. Following a three-month decay period, the solution is transferred to a shielded carrier outside the cell and then to an existing solvent extraction plant for uranium decontamination and recovery.

All "hot" equipment is located in a $12 \times 24 \times 21$ ft. underground cell located adjacent to and separated from the reactor cell by 4 feet of high density concrete. Other construction features are similar to the reactor cell with provisions for flooding the cell during maintenance periods using water as shielding. A picture of the cell (Fig. 2) prior to installing the roof plugs shows the maze of piping required for this "simple" plant. Obviously, the experimental facilities in the plant add to the complexity of the design.

Hydroclone Design and Performance

Since the entire processing scheme is dependent on efficient hydroclone performance, a significant effort has been expended over the past three years in evaluating the characteristics of these small efficient devices. Until recently industrial usage has been restricted to much larger hydroclones. Important dimensions of the three sizes of hydroclones designed for this plant are shown in Fig. 3. The nom-

Fig. 4. Integrally flanged hydroclone.



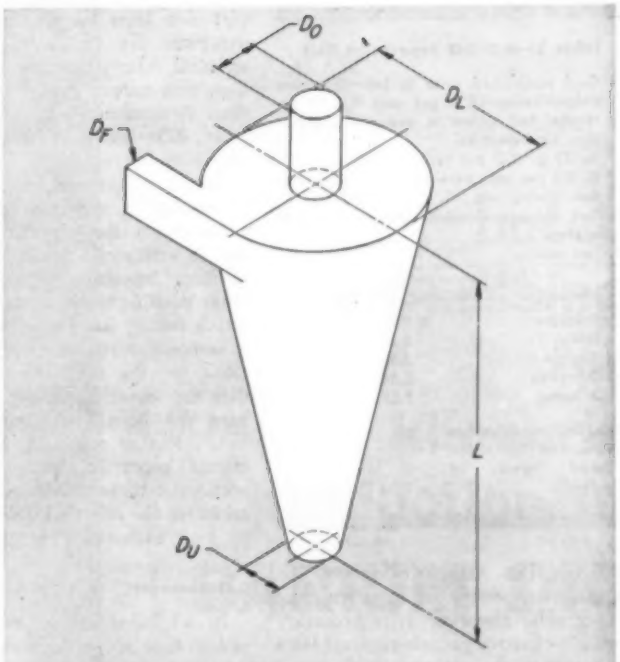
inal hydroclone size is seen to be the maximum inside diameter.

The three hydroclones are interchangeable at any time during radioactive operation through a unique, specially machined flange shown in Fig. 4. Removal of the blind closure flange exposes a cap plug and retainer plug. Removal of these with long-handled socket wrenches then permits access to the hydroclone itself. This operation has been performed routinely during cold testing.

Data accumulated during this development program, and taken in conjunction with published correlations (*2*) (*4*) (*5*) developed for hydroclones, have shown that a factor 100 larger in capacity is largely applicable to the small hydroclones utilized in the processing plant.

The important contributions to the field have been the study of extremely small hydroclones and the development of the induced underflow principle. In this mode of operation, an underflow receiver mounted beneath the hydroclone collects the separated solids without continuous letdown from a high-pressure system. The solids are subsequently drained batchwise after system pressure has been reduced.

Haas (*3*) has summarized the effect of important variables on performance of the three sizes of hydroclones which may be used in the processing plant. In Fig. 5 hydroclone efficiencies are plotted vs. solids particle size for operation with 10 g. U/kg D_2O—UO_2SO_4 solution at



SYMBOL	LOCATION	FOR HYDROCLONE SIZES OF		
		0.25	0.40	0.56
D_L	MAXIMUM INSIDE DIA.	0.25	0.40	0.56
L	INSIDE LENGTH	1.50	2.40	3.20
D_U	UNDERFLOW PORT DIA.	0.070	0.100	0.148
D_O	OVERFLOW PORT DIA.	0.053	0.100	0.140
D_F	FEED PORT EFFECT. DIA.	0.051	0.118	0.159

Fig. 3. Typical dimensions for three sizes of hydroclones.

Fig. 1. Schematic flow sheet of H.R.T. chemical plant.

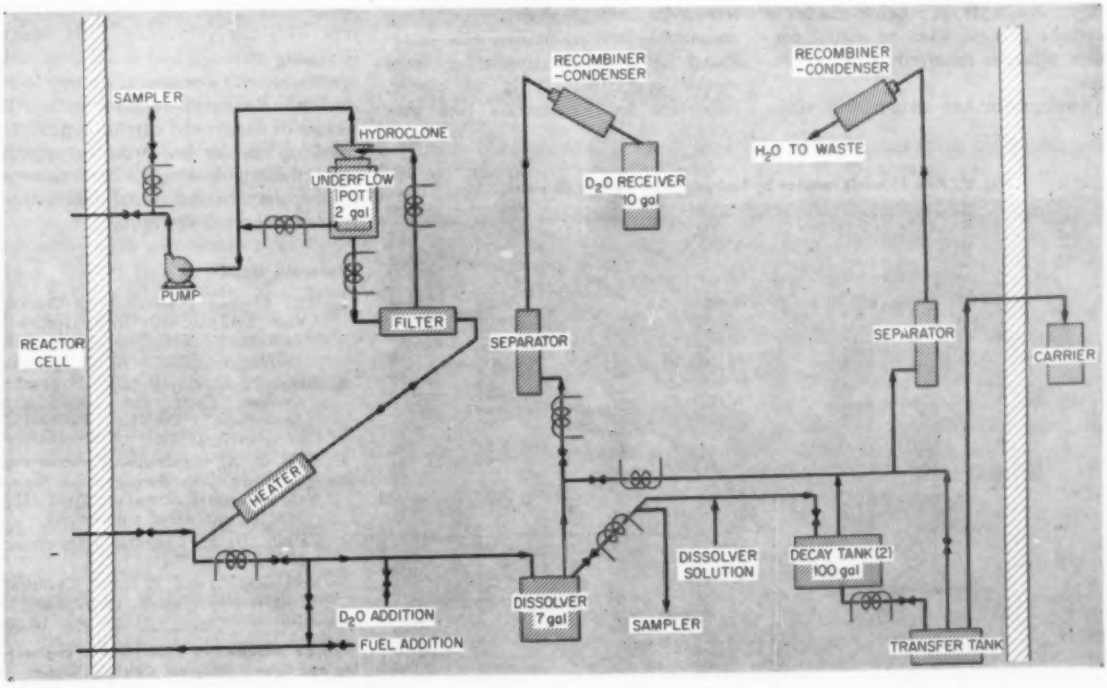


Table 1.—H_2O-D_2O Separation Test

I. Goal established prior to test—Maximum contamination of ¼ per cent H_2O in the reactor fuel system in one year's operation, equivalent to:
   A. 35 g. H_2O per cycle.
   B. 0.6 per cent increase in H_2O concentration during test.

II. Test solution—nominal 5 per cent D_2O mixture

III. Test results:

Method	D_2O Concentrations From Sp. Gr.	Mass Spec.
Precision	±0.05	±0.10
Initial	5.56	5.06
1 cycle	5.55	5.12
2 cycles	5.56	5.16
3 cycles	5.52	5.17
Note: D_2O conc. changes compared to established goal of −0.6%:	−0.04	+0.11

300° C. The higher efficiencies of smaller hydroclones are apparent from this graph. However, it is necessary to study effective particle removal rates to ascertain the optimum hydroclone. In Fig. 6, this variable is plotted, and it is evident that the largest hydroclone has, in nearly all instances, a higher solids removal rate, due to its higher flow rate. Nominal flow rates for the three sizes are approximately 0.25, 0.75, and 1.5 gal./min., respectively.

Particle sizes of simulated corrosion products, produced by autoclaving the corresponding oxides in process solutions at normal temperatures and pressures, average in the half-micron range. Attempts are being made to ascertain particle sizes of actual corrosion products removed by the hydroclone.

Development has shown that while corrosion rates for stainless steel hydroclones are excessive, titanium is an ideal material of construction for high-temperature uranyl sulfate solution. A titanium hydroclone sectioned after 4000 hours of service showed negligible corrosion.

Another important factor under investigation is the loss of suspended solids from the circulating streams due to settling in low-velocity areas, uniform deposition on pipe walls, or other possible mechanisms. Nonradioactive testing has shown these effects to compete extensively with the hydroclone for the circulating solids. To date the variables affecting deposition have not been completely separated. While loss of solids in certain areas is not important, ideally the major portion of these would be removed to minimize the effect of deposited solids on heat exchanger performance.

D_2O Recovery

In all homogeneous reactor processing flow sheets, a transition from a heavy-water to a light-water system is shown so that final processing may be performed in conventional solvent extraction equipment. This step is being demonstrated in the present plant as the initial procedure in handling the separated solids. The D_2O associated with these solids is recovered by evaporation, to be recharged in the next operating cycle. Minimization of D_2O contamination by H_2O and low D_2O losses are the essential features to be demonstrated. From the results of a test of this procedure shown in Table I, it is seen that no measurable contamination was introduced in a period simulating three weeks' operation. It is, of course, important to demonstrate like performance over extended periods of time.

Solids Handling and Dissolution

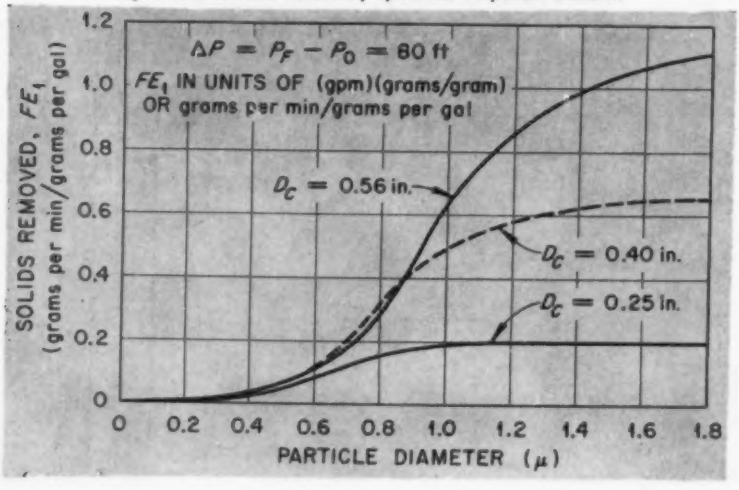
At expected corrosion rates, approximately 400 g. of corrosion products are formed in the reactor system per week. The underflow receiver was thus designed to handle this quantity of solids. To demonstrate feasibility of the design, over three times this quantity of solids was charged to the underflow receiver and drained in the normal procedure without difficulty.

Full-scale dissolution procedures have also been adequately tested. To minimize possibilities of contamination by foreign ions, a dissolution procedure was developed employing only sulfuric acid. The dissolution cycle, consisting of a 4-hour reflux with 10.8M H_2SO_4 followed by a 4-hour reflux with 4M acid is repeated as required until complete dissolution has been attained. Tests have repeatedly demonstrated greater than 99.5 per cent dissolution of simulated corrosion and fission products in two such cycles. The 5-gal. dissolver is lined with tantalum for corrosion resistance. Decay storage tanks and all equipment required to handle the 4M boiling H_2SO_4 is fabricated of Carpenter-20 stainless steel.

Operation and Performance to Date

Prior to reactor criticality, the hydroclone system was operated approximately 1800 hours. Of this 600 was as an integral part of the reactor system with the remaining 1200 hours including start-ups and shutdowns and operation with a temporary pump loop during initial solids removal tests. All phases of fission and corrosion product handling in the low-pressure system were thoroughly tested. Performance of the plant during initial radioactive runs is reported orally.

Fig. 6. Rate of solids removal by hydroclone vs. particle diameter.



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To be presented at 1958 Nuclear Engineering and Science Congress, Chicago, Illinois.

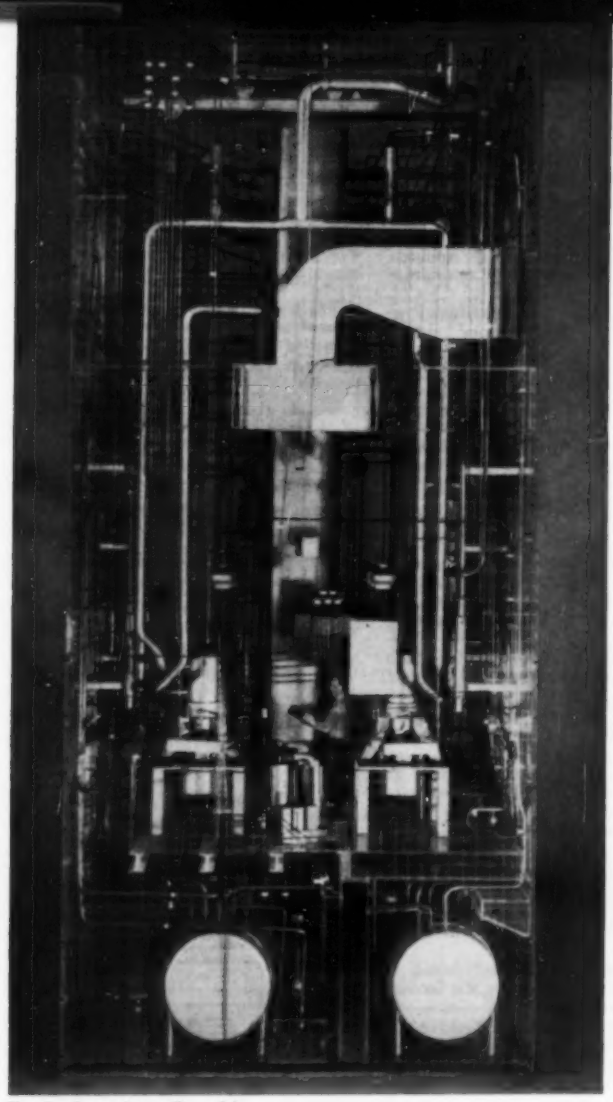


Fig. 2. Processing cell model.

batch processing for kilocurie production of BARIUM-140

A new batch processing facility recovers kilocurie quantities of barium-140 from short-cooled MTR fuel. The process is based on the solubility characteristics of barium and barium salts in selected basic and acidic media. Several of the techniques used are probably applicable to other radiochemical recovery operations. A significant feature of the process is its unique ability to handle short-cooled fuels.

A. L. Ayers and B. M. Legler

Phillips Petroleum Company, Atomic Energy Division, Idaho Falls, Idaho

The recovery of fission product barium-140 in kilocurie quantities from spent MTR fuel elements is now a routine operation in a plant conceptually designed and operated by Phillips Petroleum Company's Atomic Energy Division at the National Reactor Testing Station. The process as developed by Phillips, based on some prior work at ORNL, depends upon alternate dissolution and precipitation of irradiated MTR fuel element components containing up to 50,000-curie quantities of barium-140, in selected reagents. Liquid-solids separations are made in a special solid basket centrifuge which serves as reaction vessel as well as decanter. Recovery efficiency is 70%. Operating time per batch is 30 hours. Engineering design of the plant was done by the Blaw-Knox Company and construction by J. F. Pritchard.

Barium-140 amounts to less than 0.02 per cent of the total weight of a 4 kg. MTR fuel assembly. Radiobarium produced is shipped to customers who use the decay product, radiolanthanum, as high specific activity sources in various research programs. The half-life of barium-140 is 12.8 days and that of lanthanum-140 is 40.2 hours. Principal lanthanum gamma activity is 1.6 mev.

A by-product uranium stream from the plant is suitable for recovery of uranium in ICPP liquid extraction facilities. A by-product strontium stream also from the plant is collected in special shielded storage tanks to await recovery of strontium-90 after adequate decay to reduce the strontium-89 concentration. Strontium recovery is to be conducted in barium recovery equipment when demand for strontium develops. Waste streams are acidified to make them compatible with other ICPP wastes.

Design Philosophy

The plant is designed for remote operation because of estimated activity levels up to 10^7 roentgens per hour. Solution transfers are made by air jets, air lifts, or through gravity flow. Mechanical pumping is avoided in keeping with the general philosophy of minimizing maintenance. Remotely operated air or solenoid valves are used where valving is absolutely necessary in process lines. Otherwise valving is avoided to minimize contamination buildup. Shielding is designed to provide levels of not more than one milliroentgen per hour in the operating areas adjacent to the cell. Ordinary six-foot thick concrete provides sufficient protection. Equivalent shielding is maintained through a lead glass

window used to facilitate mechanical manipulations which are carried out in the process. Key mechanical equipment is provided with remote oilers.

The general philosophy of direct maintenance employed at ICPP is maintained in this part of the plant. All vessels are provided with a method for adding and removing decontamination solutions so the radiation level can be reduced to tolerable limits for repairs or alterations. The two successful decontaminations which have been carried out prove the feasibility of the concept of direct maintenance for the extremely high level activity encountered in this process.

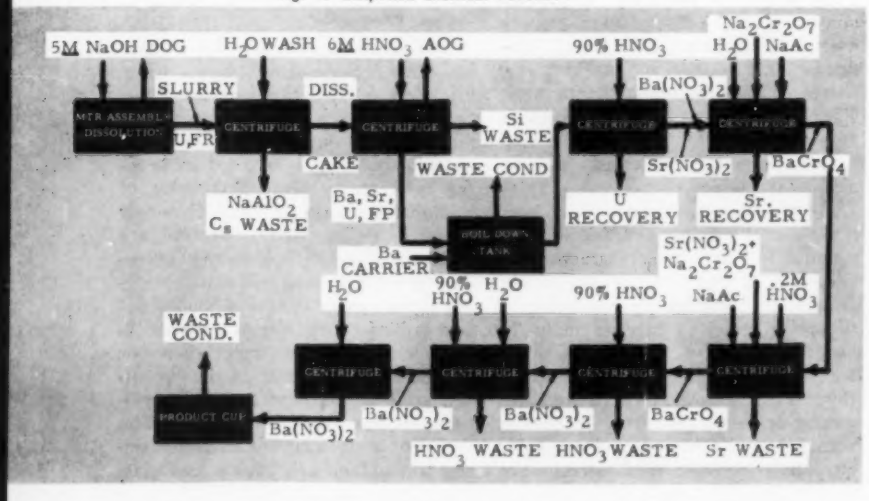
Process Description

Source material for each batch of barium-140 is one MTR fuel assembly irradiated to provide up to 50,000 curies of barium-140 two days after reactor discharge. There is no other known process handling spent fuels with such short cooling periods. A simplified chemical flowsheet is given in Figure 1. A brief process description follows:

1. One irradiated MTR assembly is dissolved in five-molar sodium hydroxide solution under temperature controlled conditions. Aluminum and cesium are selectively dissolved leaving silica, uranium, and other fission products as insoluble particles in suspension. Evolved hydrogen and xenon pass through a caustic scrubber to a gas holder unless meteorological conditions permit direct venting to the atmosphere.
2. Dissolver slurry is centrifuged to separate solution from particles which remain in the solid basket centrifuge. Particles are washed with water.
3. Particles are contacted with six-molar nitric acid to dissolve uranium, barium, and other fission products away from silica and other insoluble components.
4. Centrifugation is employed to remove dissolved constituents from insoluble components.
5. Insoluble components remaining in the centrifuge are slurried with water and transferred to a waste tank.
6. Carrier barium is added to dissolved constituents from Step 4 and specific gravity controlled evaporation is conducted to initiate precipitation of barium and strontium as nitrate salts. Addition of fuming nitric acid to the concentrate completes the precipitation.
7. Nitrate solution is centrifuged to remove dissolved uranium and fission products from barium and strontium nitrate precipitates.
8. Nitrate precipitates are dissolved in water. Addition of sodium dichromate effects conversion of nitrates to chromate salts in solution. Four-molar sodium acetate is added to buffer the solution to $ph\ 4.25 \pm 0.25$ where barium chromate is selectively precipitated.
9. Chromate solution is centrifuged to remove dissolved strontium from precipitated barium chromate.
10. Barium chromate is dissolved in two-tenths molar nitric acid. Inactive strontium carrier is added to improve active strontium decontamination. Addition of sodium dichromate and sodium acetate causes selective precipitation of barium chromate as before.
11. Chromate solution is centrifuged to remove dissolved strontium from precipitated barium chromate.
12. Metathesis of barium chromate to barium nitrate is effected by addition of fuming nitric acid.
13. Excess acid is removed by centrifugation.
14. Barium nitrate is dissolved in water and reprecipitated upon addition of fuming nitric acid. From this point the lanthanum growth from barium decay is retained in the final product.
15. Nitrate solution is centrifuged to remove final impurities from the barium nitrate precipitate.
16. Barium nitrate salt is dissolved in water and transferred to a product cup where evaporation reduces barium nitrate to dry crystalline form.

Product specifications limit total metallic impurities to fifty milligrams and strontium activity to ten curies. Inactive barium-138 is limited to seven grams.

Fig. 1. Simplified chemical flowsheet.



Equipment Description

All vessels and piping are constructed of Type 347 stainless steel. A centrifuge is the processing "heart" of the system. Two lines of centrifugation equipment provide a processing line and an installed stand-by line.

The plant contains approximately three miles of piping within a stainless steel lined processing cell 16′ × 17′ × 36′ high. A model of the processing cell is shown in Figure 2.

The centrifuge, Figure 3, is a suspended, batch, solid basket type used to effect removal of 0.2 to 60 liters of supernatant liquor from gram quantities of radioactive solids. Two independent mechanical skimmers provide for supernate removal. Solids are removed as slurries. The jacketed solid centrifuge basket is 16¾ in. I.D. by 6¾ in. deep, rotates inside a jacketed case. Operating speed of 2,600 rev./min. provides a separating force of 1,500 × gravity. Mechanical control rods for remotely operated auxiliaries extend straight through the six-foot concrete shielding walls.

Major processing equipment is shown schematically in Figure 4. Processing begins in the dissolver. The dissolver slide valve is opened to receive an MTR assembly from a shielded carrier-charger. Caustic solution is charged to the dissolver by a metering pump. Dissolver off-gas is cooled in the dissolver reflux condenser before flowing to a packed column. There it is scrubbed countercurrently with one-molar sodium hydroxide and one-tenth molar sodium thiosulfate solution to remove radioactive iodine. A vacuum is maintained on the dissolver off-gas system so that any leakage will be into the system. Dissolver slurry containing about 200 grams of solids in fifty liters of solution is air-jetted to a feed pot. An internal constant head orifice in the feed pot provides a constant flow of dissolver slurry to the centrifuge. Overflow from the constant head orifice returns to the dissolver.

A supernate tank receives solution skimmed from the centrifuge. Air-operated jets provide for transferring contained solution to waste, storage, or process vessels. A boildown tank contains a solenoid-operated valve at the bottom outlet. This tank is used to evaporate nitrate solution to initiate precipitation of barium and strontium. A drying station utilizes electric heating coils to reduce to dryness product solution skimmed from the centrifuge. A remote manipulator handles the platinum-lined product container which is loaded in a shipping cask. Visual observation of the manipulator is fa-

cilitated by a lead glass window in the cell wall. A cable-operated platform elevator removes the shipping cask from the radioactive processing area.

Reagent additions to the process are made through pressurized addition funnels to preclude backup of radioactive material to operating areas. Purged-probe-type level and gravity instruments are used throughout the process. Radiation alarms in operating areas warn of unsafe radiation levels. Several process vessels are provided with remote samplers for accountability of contained components. A negative pressure is maintained in cell vessels through a vessel off-gas system. The cell area is also maintained at a negative pressure with respect to operating areas to preclude outflow of contaminated air. Incandescent lights are used for normal cell illumination. Stand-by sodium vapor lights are used when more intense illumination is required.

Operating Results and Techniques

Start-up operation included fifteen runs involving no active material and three runs involving low activity material. In the initial eight high activity level runs barium production averaged 24,000 curies per batch for a 70 per cent recovery. In one demonstration run, using a MTR fuel element with greater than normal burnup, 49,000 curies of barium-140 were recovered. Because normal customer requirements are 25,000 curies per batch subsequent runs were at a reduced level.

Uranium recovery is of the order of 80 per cent in the process while strontium recovery is 60 per cent. Barium losses are high in some batches but no consistent loss pattern has developed. All waste streams are analyzed for barium as well as uranium. Product barium quantity is determined by a calibrated photoneutron counter based on gamma activity from lanthanum-140 growth.

The plant is operated by a total of eight persons including supervision. Operating time is thirty hours per batch. Estimated production cost is under five dollars per curie separated. Sampling represents the greatest source of radiation exposure to operating personnel; however, careful monitoring by field Health and Safety personnel insures that allowable exposure limits are not exceeded.

Product loading causes some radiation exposure since the product shipping cask is handled directly after being exposed to cell environs. Other operations result in negligible exposure to operating personnel.

The following problems unique to the barium recovery cell dictated es-

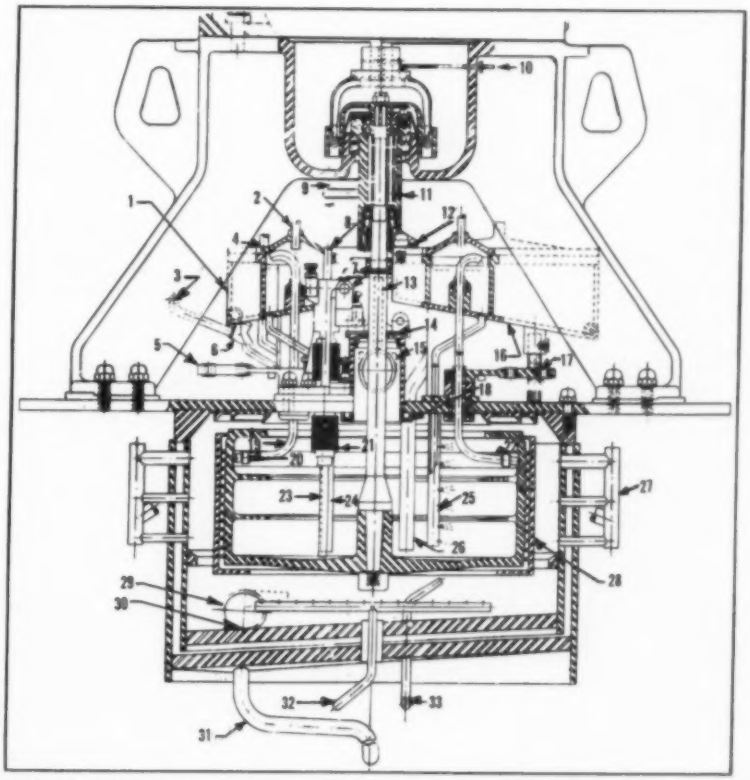
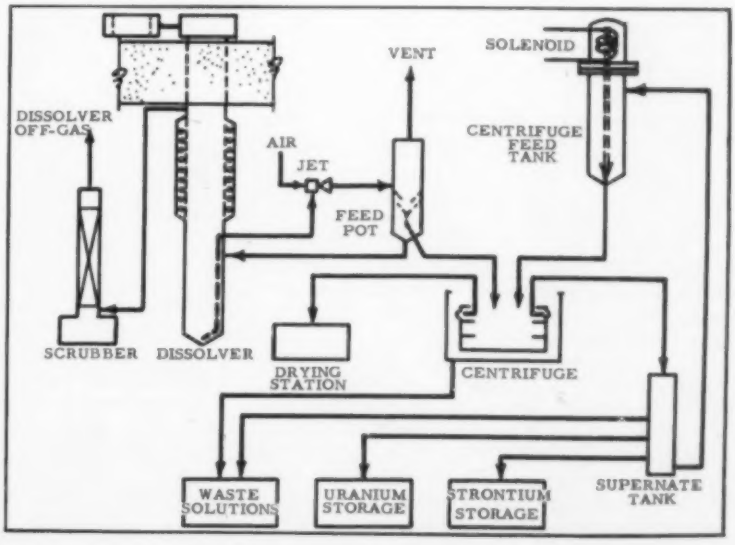


Fig. 3. Centrifuge section. 1—one-liter kidney. 2—vent from skimmer pot. 3—feed from centrifuge feed tank. 4—feed from dissolver. 5—skimmer control. 6—manifold. 7—suction line control. 8—jet suction. 9—drain. 10—oil feed. 11—oil feed. 12—oil drain. 13—hood spray. 14—carbon seal. 15—vent. 16—five-liter kidney. 17—skimmer control. 18—case ring spray. 19—skimmer. 20—splash plate. 21—bellows. 22—skimmer. 23—jet suction. 24—feed line. 25—bowl spray. 26—thermowell. 27—case spray. 28—jacketed bowl. 29—case drain. 30—low point in case. 31—case jacket outlet. 32—bowl underside spray. 33—feed to bowl jacket.

Fig. 4. Simplified flow diagram.



tablishment of special operating techniques:

1. Operation of the barium recovery cell is on an intermittent basis with a month or more between runs making it difficult for operators to retain intimate knowledge of the process steps.
2. The multiplicity of operations requires rigid control of one or more variables in order to obtain satisfactory separation of materials.
3. The intense activity of processing solutions makes it highly probable that uncontrolled escape of these solutions from the operating cell would at least cause suspension of plant operation for extended periods and would make dangerous exposure of personnel a distinct possibility.
4. Weather dependency of the process makes it necessary for a run to proceed with maximum dispatch commensurate with the other factors just mentioned.

Special operating techniques include a run sheet for each run which contains comprehensive "cookbook-like" instructions for each step in the operation including prerun and postrun checking of equipment and instrumentation. Throughout the run a supervisor confirms the procedure before each step is started, records data on the run sheet, and indicates the completion of each step by inserting the initials of the person who performed that specific task in a space provided in the run sheet. This provides a check that each operation is performed and that it is performed correctly. Critical valves are locked with padlocks each requiring a specific key. When the procedure requires these valves to be opened, the specific key for the valve to be opened is given to the operator by the supervisor. The valve is then locked and the key returned to the supervisor as soon as the valve is closed.

Manipulators are indexed and the settings required at each station are posted so that even if all lighting inside the cell failed it would be possible to complete a run without observation in the cell.

A number of samples taken during and after a run must be allowed to decay for two or more weeks to prevent overexposure of analytical personnel. Activity of three to four milliliter samples may be up to 25 roentgens at a distance of four feet.

Waste Handling

The greatest problem associated with barium separation is evolution of radioactive iodine during disposal of both gaseous and liquid wastes. The release of radioactive xenon is also a problem but it is insignificant when compared to iodine. Liquid wastes per se are easily handled in existing underground storage tanks. These tanks are routinely used for storage of wastes from the recovery of uranium from spent aluminum-uranium fuel elements. Sparging, evaporating, or transferring any liquid waste solutions in the barium recovery process usually results in evolution of iodine.

Radioactive xenon is liberated during the caustic dissolution, with up to 60,000 curies being liberated in about thirty minutes. The primary hazard associated with this material is direct radiation since the gas is inert and has only limited solubility in body fluids. The rapid evolution makes it possible to store the gas for release under favorable weather conditions.

The release of iodine is erratic varying both in quantity and time of discharge from run to run. However, more than 99 per cent of the iodine is permanently retained in process waste solutions and the off-gas scrubber. Scrubber efficiency is greater than 99.5 per cent. A small amount of iodine is released to the cell atmosphere and thus by-passes the scrubber. Limited capacity precludes storage of cell iodine-bearing off-gas. Iodine release may start any time after the caustic dissolution; however, initial discharge usually coincides with acid dissolution of dissolver residue. Usually the concentration rapidly increases to a maximum. Depending upon the amount of sparging, transferring, and evaporating that is made subsequent to the run, maximum evolution may occur as late as a week or two after the actual separation run. All dissolutions and subsequent handling of waste solutions and samples are made under favorable weather conditions. Extensive metering of the areas down-wind from the point of gaseous activity discharge indicates very little contamination of vegetation. A study of radioactive iodine concentration in the thyroid glands of rabbits in these areas indicate little hazard to humans even if these areas were occupied. An extensive development program indicates that installation of carbon beds into the off-gas lines should retain sufficient iodine to make the operation independent of weather. Since these beds are currently under construction, no data are available as to their effectiveness.

The iodine build-up in waste evaporator condensates is a problem because local restrictions regulate the release of radioactive iodine to the water table. Elimination of iodine from condensates and relaxation of release restrictions are possible solutions to this problem.

One other significant problem that has been noted in conjunction with the iodine release is increased maintenance costs for the iodine-contaminated equipment. This equipment must be decontaminated to limit personnel exposures. Even after intense decontamination, working times must be limited and many jobs must be done piecemeal by several different people to minimize exposure.

Decontamination and Maintenance

As previously mentioned, two decontaminations have been carried out, one after low level activity runs and the second after sustained runs at operating levels.

The initial decontamination required 400 man-hours in reducing the general background radiation from an estimated 1,000 roentgens per hour to 0.3 to 1 roentgen per hour in 39 days. This decontamination was made at leisure, so the elapsed time is not a good indication of what could be done expeditiously.

The second decontamination reduced the level in the cell from an estimated several thousand roentgens per hour to a general background of 250 to 300 milliroentgens per hour in 29 working days. Decontamination solutions used were those normally employed at ICPP including nitric acid, 20% sodium hydroxide—5% tartaric acid, 3% sodium fluoride—20% nitric acid followed by aluminum nitrate solution washes. The outside of in-cell equipment was washed with sodium hydroxide, Turco, and nitric acid solutions. All readily accessible equipment was reduced in activity to the general background of 250 to 300 milliroentgens per hour allowing a working time of approximately one hour per man per week.

The maintenance work necessary to maintain the cell has been nominal with the exception of the photoneutron counters which are employed to measure the separated product. The counter is currently being replaced with more reliable instrumentation.

Corrective maintenance at the completion of decontamination included repair of a solenoid valve, inspection of mechanical equipment, and replacement of in-cell lights.

To be presented at 1958 Nuclear Engineering and Science Congress, Chicago, Illinois.

nuclear briefs

Containing selected portions and condensations of papers to be presented at the forthcoming Chicago Nuclear Engineering and Science Conference, with the exception of the first brief in the group (below) which is based on a paper presented at the recent Washington, D. C. Saline Water Conversion Symposium.

Nuclear heat to distill saline water ?

Exhaust steam of low energy level is seen as a basis for economical saline water distillation.

It has been proposed that various combinations of vapor compression, multiple-effect distillation processes, and power generation would result in low-cost water. This study* was made to determine the best combination of reactors and distillation processes to produce the lowest cost water.

The current cost of electrical energy from nuclear plants cannot compete with costs of plants using fossil fuels. Prospects for fresh water from sea water then become primarily a matter of improving the conversion processes. For single-purpose plants requiring low-level heat, nuclear energy is potentially feasible compared to other fuels. Increased cost of high temperature reactor operation would tend to offset the higher efficiency of any combination of vapor compression and multiple-effect distillation. A basis of comparison can be established by selecting a type of reactor and a temperature level that will produce the lowest cost energy in the form of steam. Exhaust steam from power generating plants has been considered as a possible source of energy, therefore it must be weighed against all possible nuclear methods.

* Condensed from a paper, "The Role of Nuclear Energy in Water Conversion Processes," by W. R. Hainsworth, D. B. Brice, and M. R. Dusbabek, Fluor Corporation, Whittier, Calif., at the Washington, D. C. Saline Water Conversion Symposium, November, 1957.

Combined Power and Distillation Plant

Operating data and cost of a modern steam power plant have been analyzed to determine the effect of exhaust steam temperature on the cost of power. The analysis shows the cost to be 22.4¢/1,000 lb. steam to the distillation plant. (The relationship of condensing temperature, power plant capacity, quantity of exhaust steam, and cost of energy/kw.-hr. is shown in Figure 1.) In a multiple-effect still producing 8 lb. of fresh water/lb. of steam, the plant capacity would be 10½ million gal./day at a cost of 23.3¢/1,000 gal. Although the cost of exhaust steam is low on this basis, the overall capacity of the power plant is reduced 25 per cent and the ratio of water produced to power produced is 8.7 gal./kw.-hr.—much less than the present ratio of usage in most communities.

If the plant operates at various load factors when tied in with a power network and existing water system for some localities, it may be more economical to use some of the power for vapor compression combined with multiple-effect or flash distillation systems. This concept may be extended until power becomes a by-product and the production of fresh water becomes the primary purpose of the plant.

Nuclear Fuel Costs

Fuel charge, a major component of thermal energy cost, is far more difficult to evaluate for nuclear energy than for conventional fuels. A general analysis of nuclear fuel cost as a function of burn-up, parametric in enrichment, conversion ratio, and reprocessing and fabrication is possible because we are concerned with a narrow enrichment range and small conversion ratio. The total fuel cost, with the cost components, is shown in Figure 2. In general, the full cost of energy (without inventory charge) approaches zero at burn-up in about 5,000 megawatt-days/ton of fuel in the reactor. The total energy cost for the distillation process is the sum of reactor inventory cost, amortization, and operating cost of the reactor.

Conventional Reactor Types Used

The three reactor systems selected for scrutiny as low temperature steam sources are:

1) Graphite-moderated, heavy water-cooled, natural uranium-fueled.
2) Heavy water-moderated and cooled, natural uranium feed.
3) Light water-moderated and cooled, slightly enriched uranium fueled.

All three are fueled with aluminum-clad elements. Figure 3 displays steam

cost components for all three at 220° F. The cost breakdowns shown are based on Office of Saline Water standard procedure, where applicable. The fuel charge disparity between heavy and light water is due to the plate-type elements used in the latter. The variation of steam cost with steam temperature in each reactor is shown in Figure 4. This does not necessarily represent the minimum obtainable steam cost.

Conversion Processes

The next factor to consider in establishing the final cost of water is the cost of the distillation system to be used with the reactor. Since the use of heat from a nuclear reactor does not seem to be advantageous for the production of mechanical or electrical energy at high temperatures, the selection of the conversion process to be used is limited to a low-level vaporization process. Three distillation systems selected for study are:

1) Multiple-stage flash evaporator.
2) Multiple-effect, long tube evaporator.
3) Multiple-effect, submerged tube evaporator.

Besides being about the only systems able to use low-level energy efficiently, these represent the only types of large commercial conversion plants in operation today. The curves in Figure 5 show how the total cost of producing water varies with the number of stages in a flash system, with steam cost for a 2° F. approach temperature* using 220° F. steam, and water cost for eight stages using a 10° F. approach. When steam cost is about 20¢/1,000 lb., the cost of water is about the same from the high and low approach plants. By coincidence, the estimated minimum cost of 220° F. steam from the nuclear reactor selected is about 20¢/1,000 lb. Thus the approach temperature has little influence on the cost of water.

Figure 6 shows the variation in cost of water for both flash and multiple-effect evaporators at 2° F. approach for three steam condensing temperatures using the corresponding steam costs from the heavy water reactor for each temperature. It should be noted that the development of a cheap means of scale prevention at higher temperatures is required before a cost reduction can be obtained by the use of higher temperatures.

* Flash stage approach temperature is defined as temperature difference between the condensing vapor and exit sea water.

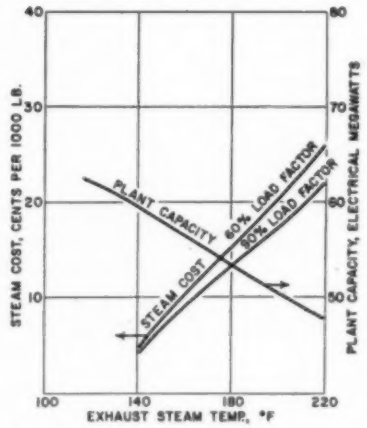


Fig. 1. Power plant exhaust steam cost vs. steam temperature. (Fuel cost = 40¢/million B.t.u.).

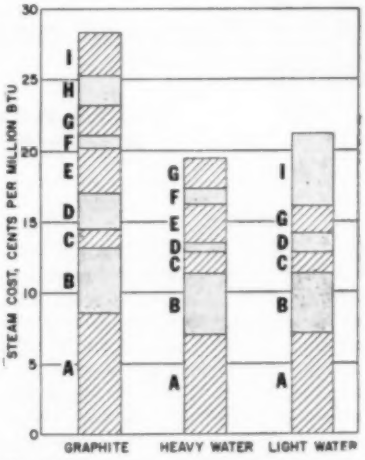


Fig. 3. Steam cost components for 3 reactors. Key: A-reactor building, shielding, control instruments, etc.; B-operation and maintenance; C-piping and steam generator; D-fuel inventory; E-D_2O inventory; F-D_2O loss; G-pumping cost; H-graphite inventory; I-fuel cost.

THE COST PICTURE

A heavy, water-moderated and cooled reactor, combined with a seven-stage, long-tube vertical, multiple-effect evaporator, produces the lowest cost water and seems to be the best combination of systems studied. For this combination:

	water ¢/1,000 gal.
Capital costs	
a. reactor plant	14.5
b. distillation plant	26.8
Fuel costs (total energy)	4.7
Operation and maintenance costs	
a. reactor plant	7.0
b. distillation plant	10.0
Total water cost	63.0

A digital program to evaluate transients for

The simulation of the varied operation of a heat generation and transfer, and fluid mechanics system associated with a mobile nuclear power reactor has been accomplished using an IBM-704 digital computer. Equations used in the model of the simulated system are given.

Knowledge of the transient characteristics of a system are important in its design and operation. A digital computer has been used to simulate the transient behavior of a pressurized-water nuclear reactor and its associated heat transfer and power generation equipment. The operation of the reactor has been coded for use in an IBM-704 electronic data processing machine. The thermodynamics, fluid

Condensed from a paper by F. J. Scheib and A. J. Arker, Knolls Atomic Power Laboratory, Schenectady, N. Y., to be presented at Chicago Nuclear Congress.

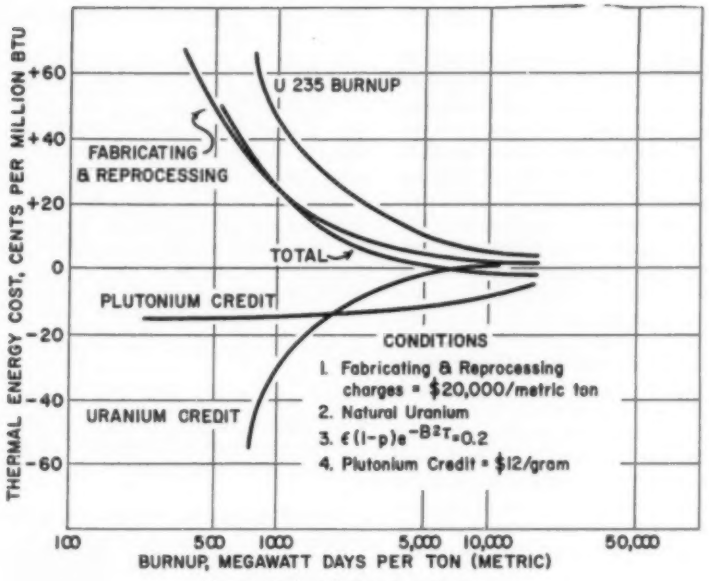


Fig. 2. Nuclear fuel costs vs. burn-up.

nuclear briefs

COMING SOON

The Nuclear Engineering and Science Conference papers briefed on these pages will be printed in full in the forthcoming Symposium Series Volume Number 24.

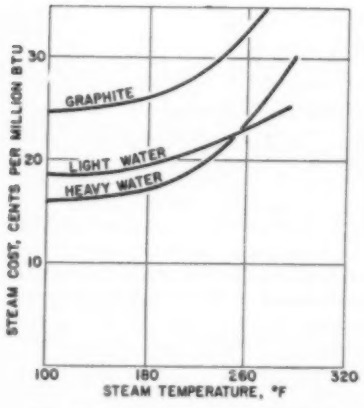


Fig. 4. Cost of steam from reactors vs. steam temperature.

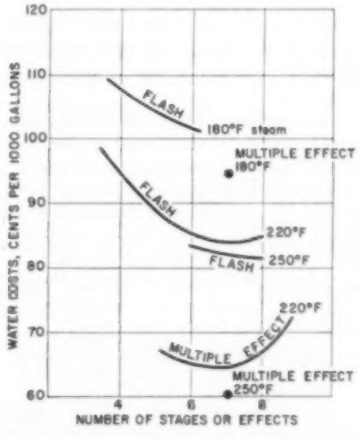


Fig. 6. Water costs vs. number of stages or effects for minimum steam cost.

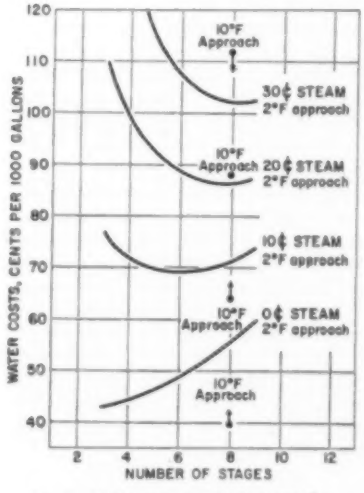


Fig. 5. Water costs vs. flash stages for various steam costs.

nuclear power plant design

flow, and kinetics used in the system under consideration are sufficiently similar to those encountered in the chemical process industries as to be applicable there also.

The performance of a nuclear power plant may be adversely affected and its safety may be jeopardized by its behavior during transients. These temporary large oscillations of the system are likely to occur when power, pressure, or thermal levels are changed rapidly. To facilitate the analysis of these transients was the primary objective of this digital program. This was possible because of the ability to simulate the power plant accurately, simple operation of the coded program, and easy alteration of the program.

Physical Basis of Model

The model represented in this digital program was a mobile pressurized-water nuclear reactor consisting of a reactor, two coolant piping loops, two steam generators (one in each of the two coolant piping loops), an automatic rod-control system, and a reactor protective system. A schematic diagram of the system is shown in Figure 1. The program was developed chiefly for use as an aid in making decisions concerning the design and operation of the nuclear plant system and its components. The program was also used to establish the operating limits of the completed design.

The Physical System

In more detail the reactor has an inlet plenum, a core region, and an outlet plenum. In the reactor inlet plenum, two incoming coolant streams are mixed, and a stream of uniform temperature is discharged to the core. The core contains a fuel element region, where the heat is generated, and a reactor coolant flow path. There are

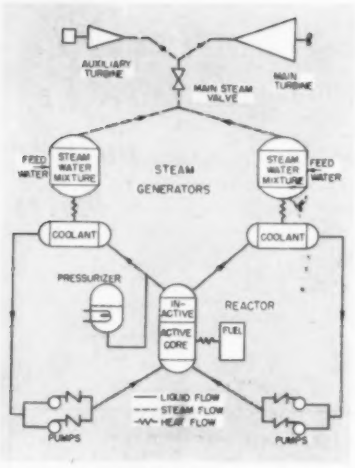


Fig. 1.

also several flow paths parallel to the principal path which represent the leakage flows. The over-all heat transfer coefficient between the fuel elements and the reactor coolant is composed of an equivalent conduction resistance in the elements and a film resistance in the coolant which varies with the flow rate. Coolant enters the tubes through an inlet plenum and leaves via an outlet plenum. Subcooled feed water enters the steam-water volume, which is represented as a uniform mixture at saturation, and saturated steam leaves it. The steam flows from each generator into a single line leading to the turbines. The over-all heat transfer coefficient between the reactor coolant and the steam-water mixture is composed of a coolant film resistance varying with flow rate, a boiling film resistance varying with pressure and heat flux, and a wall plus fouling resistance.

Simulation of the System

The coolant flow path in the reactor, the steam generator, and the fuel element region in the reactor is divided into sections called nodes. An appropriate number of nodes provides accurate simulation of slug flow in the coolant when there is heat transfer between the coolant and its surroundings. The use of nodes also provides adequate representation of reactivity feedback due to temperature changes. Flow of coolant is represented as slug flow (no mixing in the direction of flow) everywhere except in the plenums, where mixing is presumed. Slug flow is simulated by an approximate time delay * in the reactor and steam generator, and by an exact time delay * in the coolant piping. Heat capacity of the coolant includes that of a portion of the structural metal which is in contact with the coolant.

Reactor power transients, which are caused by changes in total reactivity, are calculated from six-delay-group kinetic equations * devised for this case. Total reactivity in this model is the sum of the reactivity feedback due to temperature changes and the reactivity due to control rod movement. The latter is actuated by the automatic rod-control system model or the reactor protective system model. When the combined action of the natural temperature coefficient and the automatic rod-control system are not sufficient to maintain the reactor within its design limits, the reactor protective system assumes control. In the actual control system, the operation is accompanied by practical characteristics such as electrical time delays, and mechanical backlash. Wherever possible, these have been represented in the model for the control system.

Mathematical Description of Model

Basic equations typical of those used by the program are given below. They are not intended to be the detailed equations used in the actual computations.

A general heat and mass balance applicable to any coolant node in the reactor or steam generator, or to a fuel node in the reactor, is:

$$\underbrace{\frac{dT_n}{dt} = \frac{W_n S_n}{C_n}(1+z)(T_{n-1} - T_{n+1})}_{a} \underbrace{- z\frac{dT_{n-1}}{dt}}_{b} + \underbrace{\frac{Q_n}{C_n}}_{c} + \underbrace{\frac{G_n}{C_n}}_{d} \quad (1)$$

where

$$Q_n = U_n A_n \Delta T_n \quad (2)$$

$$U_n = \psi(W_n, Q_n, T_n). \quad (3)$$

The particular terms of Equation (1) which are applicable to a given node depend upon four factors: the presence or absence of coolant flow through the node, of heat transfer across the node, and of heat generation in the node, and (if coolant flow is present) the type of flow model presumed. Table 1 summarizes the application of Equation (1) in this digital program.

In Table 1, the parameter z is dependent upon the flow model. Value for z ranges from zero for slug flow (no mixing in direction of flow) to one for plenum flow (complete mixing). The combination of terms a and b when $z = 1$ is the representation of slug flow by an approximate time delay, in which the node temperature is the arithmetic mean of the inlet and outlet temperatures, i.e.,

$$T_n = \frac{T_{n-1} + T_{n+1}}{2}$$

The use of term a when $z = 0$ represents plenum flow by complete mixing, in which the node temperature is equal to the outlet temperature, i.e., $T_n = T_{n+1}$.

Slug flow in the coolant piping is represented by an exact time delay as:

$$T_{n+1,t} = T_{n-1,t-\tau} \quad (4)$$

where

τ is defined by $\int_{t-\tau}^{t} W_n dt = \rho V_n$ (5)

The heat and mass balances used in the steam-water mixture in a steam generator are:

$$\frac{dh_g}{dt} = \frac{W_f h_f - w_g h_g + Q_s}{M_s} \quad (6)$$

$$\frac{dM_s}{dt} = W_f - w_g \quad (7)$$

Equations for the steam line, main turbine, and auxiliary turbine are:

$$P_t = P_s - K_1(\Sigma w_g)^2 \quad (8)$$

$$\Sigma w_g = w_m + w_x \quad (9)$$

$$w_m = K_2 \Omega_m P_t \quad (10)$$

$$w_x = K_3 \qquad P_t \geq K_4 \quad (11)$$

$$w_x = K_4 P_t \qquad P_t < K_4 \quad (12)$$

The six-delay-group kinetic equations are:

$$\frac{l}{\beta}\frac{d\phi}{dt} = \Sigma_i \lambda_i y_i + (\Delta K - 1)\phi \quad (13)$$

$$\frac{dy_i}{dt} = f_i \phi - \lambda_i y_i \quad (14)$$

$$\Delta K = \Delta K_r + \Delta K_c \quad (15)$$

Table 1.—Application of Heat and Mass Balance—Equation 1

Location and Type of Node	Terms of Equation (1) Used; Value of z
Coolant node in reactor or steam generator plenums	a; $z = 0$.
Coolant node in reactor active core or in steam generator tubes	a, b, c; $z = 1$
Coolant node in reactor inactive core	a, b; $z = 1$
Fuel element node in reactor active core	c, d

* See descriptive equations.

Notation

A = heat transfer area
C = heat capacity
f = fraction of the total delayed neutrons produced
G = reactor heat generation rate
h = enthalpy
ΔK = total reactivity
ΔK_c = reactivity due to control rod movement
ΔK_r = reactivity feedback due to temperature changes
k = constant of system
l = prompt-neutron lifetime
M = mass
P = pressure
Q = net heat transfer in
S = specific heat
T = temperature
T_{n-1} = inlet temperature of node n
T_{n+1} = outlet temperature of node n
ΔT_n = temperature difference between node n and a heat source or sink
ΔT_z = difference between reactor inlet and outlet coolant temperatures
t = time
U = over-all heat transfer coefficient
V = volume
W = mass flow rate of liquid
w = mass flow rate of steam
y = normalized concentration of delay neutrons
z = parameter dependent upon flow model; value ranges from zero for slug flow (no mixing in direction of flow) to one for (complete mixing).
β = fraction of total neutrons produced as delay neutrons
λ = decay constant of delay neutrons
ρ = density
Σ = summation of
τ = particle transport time between inlet and outlet of node n
ϕ = normalized reactor neutron power
ψ = function of
Ω = throttle area

SUBSCRIPTS

f = feedwater into steam generator
g = steam flow from steam generator
i = delay-neutron group
m = main turbine
n = reactor coolant node
s = saturated steam-water mixture
t = turbine throttles
x = auxiliary turbine

nuclear briefs

physical properties of stored nuclear wastes at Savannah River

Here is a description of many of the *physical* properties of neutralized (salt-containing) radioactive waste solutions. The data herein are believed to be essential to any process design consideration. For a note on *chemical* properties, see Opinion & Comment, page 55 of this issue.

Wastes from separation processes at the Savannah River plant are being stored in underground tanks to permit fission product decay. Because of the intense radiation of these wastes, they are classified and stored according to activity content. The extremely high level wastes include concentrates from the high activity waste evaporator, the low activity waste neutralizer and the head end slurry holdup tanks. The lower activity waste consists of the balance of plant wastes including the concentrate from the general purpose evaporator and the coating solution.

The high activity wastes are stored in 750,000-gal. underground tanks equipped with cooling coils to remove the fission product decay heat liberated in the tanks. Storage costs are relatively high (approximately $1.50/gal.) and there was therefore an incentive to develop methods of less expensive waste storage and disposal.

Wastes are at present stored in tanks at up to 35 wt. per cent solids concentration. This represents the highest concentration that can be maintained at ambient temperature without precipitating soluble solids. If these wastes could be concentrated to about 70 wt. per cent solids content, a reduction in volume and hence in storage costs would result. Since these studies (which were the basis of this paper) were begun, there has been a change in the long-range Savannah River waste program. High activity wastes will be stored until the radiation level has decayed substantially, followed by removal from tankage, concentrated, and stored in cheaper tank facilities. Low activity wastes will be concentrated after shorter decay periods.

In support of the Savannah River program, studies at BNL have included the following:

(1) Physical characteristics of both high and low level wastes during storage, including sludge volumes, corrosion behavior, and possible heat and radiation instability problems.

(2) Problems in the evaporation of wastes, such as scaling and foaming.

To accomplish these studies, work at Brookhaven has been divided into a pilot plant scale effort for operational information, and a laboratory scale effort for information regarding properties. In the following brief summary, emphasis will be given properties for the purpose of aiding the reader in evaluating these stored solutions as a raw material for ultimate isotope-separation processing.

Laboratory Program

PREPARATION OF SIMULATED WASTE SOLUTIONS

The Savannah River storage tanks are all made of 1020 mild steel. Therefore all wastes are neutralized with caustic. The main constituent in all streams is $NaNO_3$ with an average concentration of 33 per cent. The preparation of the simulated waste solutions was carried out to represent their generation in plant practice.

STEAM SURGE

Highly radioactive aqueous streams stored in existing tankage inevitably contain some insolubles. The insolubles vary in nature and amount depending upon the type of separations process used. When a storage tank is filled, these solids settle to the bottom in the form of a sludge and in doing so tend to carry the greater portion of the fission product activity into the sludge layer. As the sludge in the storage tank contains most of the heat-generation fission products, it generates most of the heat. The thermal conductivity of the sludge layer is less than that of the supernatant, and a situation can therefore develop in which the temperature of the sludge layer builds up to the values greater than that of the supernatant layer (*1*).

During this in-tank boiling period, it has been noted that "spontaneous rapid evolutions of steam" occur at rates 70 times the normal steaming rate (*2*). This phenomenon, which

Condensed from a paper, "Studies in Characteristics of Savannah River Wastes," by B. Manowitz, C. W. Pierce, and S. Zwickler, Brookhaven National Laboratory, Upton, New York, to be presented at the Chicago Nuclear Congress.

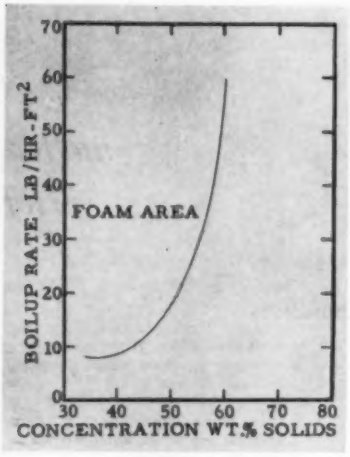


Fig. 1.

will be referred to as "bumping," seems to occur periodically and with some duration.

In comparing the Redox waste at Hanford with the Purex waste at Savannah River, the following was found: whereas Savannah River Purex waste will contain a mobile sludge after considerable aging, the sludge in the Hanford waste has a tendency to build up a hard crust at the interface, which upon breaking creates a steam surge.

CORROSION

A limiting factor in the use of tanks for storage is the corrosion by the material contained.

The 1020 mild steel samples were exposed in the various waste streams according to ASTM specifications. Of the systems studied, only the head end waste solution, complexed with gluconic acid, was corrosive to 1020 mild steel. The corrosion was very severe and was classed as transgranular with pitting and flaking off of oxides. The cause of this may be an excess of uncomplexed gluconic acid.

No corrosion occurred when the head end waste solution was diluted with the other streams. In other systems no corrosion could be observed. Most samples showed oxide crust formations, but metallographic sections revealed no corrosion.

RADIATION STABILITY OF COMPLEX

Because the high concentration of fission products in the scavenger cake waste could produce intense ionizing radiation which might decompose the MnO_2-gluconic acid complex, a series of experiments was performed to check its radiation stability. No radiation breakdown was observed at 10^7 r.; a slight precipitate was observed at 10^8 r. and a considerable amount of precipitate was produced in the sample irradiated to a dose of 5×10^8 r.

SLUDGE VOLUMES OF WASTES

The per cent volume of sludge found in the different stream samples varied between 6 and 25 per cent. The stream which contributed the most sludge was that of the low activity waste.

FOAMING

Experience with SR wastes has shown that limits must be placed on rates of evaporation to avoid foaming, which is undesirable because it increases the entrainment of radioactive solids in the overhead and complicates the operation of the evaporator. Foaming was defined as the condition when the foam level is 24 in. above the original liquid level.

Solutions containing 33 to 60 per cent solids were used in the tests. Figure 1 shows a plot of foaming points expressed as a function of boilup rate vs. per cent solids in solution.

In the evaporation of SR low level solutions it appears there is a critical region, 30 to 60 per cent solids content, in which boilup rates should be kept low, about 10 lb./hr./sq.ft., to minimize foaming. At concentrations above 60 per cent, boilup rates of 50 to 60 lb./hr./sq. ft. and higher can be used without danger of foaming.

SCALING OF HEAT TRANSFER SURFACES BY SR WASTES

Beginning with a clean coil surface at a heat flux of 10,000 B.t.u./hr./sq. ft., the calculated heat transfer coefficient varied from 200 to 130 B.t.u./(hr.)(sq.ft.)(° F.), averaging 150, for a 60-hour run of 33 per cent solution.

Rerunning with an uncleaned coil at the same heat flux, the coefficient again varied between 200 and 130 B.t.u./(hr.)(sq.ft.)(° F.) for an 85-hr. run.

A 33 per cent solids solution of *simulated* waste solution was concentrated to 70 per cent concentration and was refluxed at the same heat flux for 96 hours. The coefficient remained constant at 200 B.t.u./(hr.)(sq.ft.)(° F.)

A 70 per cent solution was refluxed with a coil at a heat flux of 50,000 B.t.u./hr./sq.ft. for 24 hr. At the end of that time the solution was replaced with fresh 70 per cent waste solution and the run was continued for another 24 hr. The heat transfer coefficient was about 600 B.t.u./(hr.)(sq.ft.)(° F.) throughout the run.

A full-scale model of a SR storage tank, representative of the existing storage tank in all ways except for diameter, was constructed. The physical characteristics of various types of waste in storage were studied. The heat transfer characteristics of stored simulated wastes were examined. The temperature profile was sought for wastes stored with and without facilities for removal of fission product heat. Some information was also obtained on concentration of wastes. This will be detailed in the full-length paper.

Literature Cited

1. Sludge Problem in Waste Storage Tanks, BNL C-7944 (March 1954).
2. Redox Waste Storage Problems, HW-31798 (May 1954).

Decomposition of reactor coolants

Radiation and thermal decomposition effects in reactor coolants have been separately investigated by the author.

A simple method has been devised to determine the maximum usable temperature for an organic coolant in a nuclear reactor. This use of organic coolants seems attractive because they have low vapor pressures, high thermal stability, and are relatively noncorrosive. The determination of the maximum temperature is based on a simple rate law governing the separate pyrolytic and radiolytic decomposition effects on the coolant polymer.

The method is noteworthy in that it applies the knowledge of the limits of a normally degradative-type mechanism to a practical use. By a method developed for this purpose, thermal effects are isolated from the radiation effects. Separate curves to represent the decomposition rates of the polymer due to temperature alone, and to radiation alone, are plotted on the same chart. The intersection of the two curves gives the desired maximum tem-

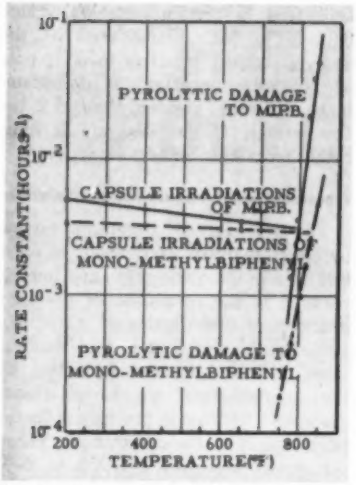


Fig. 1. Change in total decomposition rate with temperature. Radiolytic damage is at an epithermal flux of 10^{12} neutrons/sq.cm., sec.

perature. A sample plot is shown in Figure 1, where the maxima for two typical materials may be read as 795 and 860° F. respectively, for MIPB (monoisopropylbiphenyl), and monomethylbiphenyl. The rate law was derived from these curves, based on the following four reactions:

1. Pyrolytic decomposition of the pure organic compound.
2. Radiolytic decomposition of the pure organic compound.
3. Pyrolytic decomposition of the polymer.
4. Radiolytic decomposition of the polymer.

With the rate constants expressed in equivalent units, and at a given flux temperature, the rate equation is:

$$\frac{dC}{dE} = -(k_1 C - k_2 T) = -[C(k_1 + k_2) - k_2]$$

or, on integration;

$$C = \frac{1}{k_1 + k_2}\left[k_1 e^{-(k_1+k_2)E} - k_2\right]$$

where:

T is the fraction of polymer

C is the fraction of pure organic remaining: $C = (1 - T)$

E is the exposure time

k_1 is rate constant for heat and radiation damage to pure organic (in units of inverse exposure)

k_2 is rate constant for heat and radiation degradation of polymer (in units of inverse exposure)

The establishment of the rate equation constants and the details of the method may be found in the complete paper which will be published in A.I.Ch.E. Symposium Series Volume 24.

Condensed from a paper "Radiolytic and Pyrolytic Decomposition of Organic Reactor Coolants" to be presented by D. R. de Halas, General Electric Co., Richland, Washington, at the Chicago Nuclear Congress.

nuclear briefs

Ion transfer membranes remove bulk electrolytes in radioactive wastes

Using anion transfer membranes in electrolytic cells as a means of removing and separating bulk electrolytes from cationic fission products, the authors accomplished deacidification of nitric acid and precipitation of hydrous aluminum oxide in granular form.

High level radioactive waste solutions resulting from the processing of certain nuclear fuels contain large amounts of inert salts, such as aluminum nitrate and/or free acid such as nitric acid. The concentration of such bulk electrolytes greatly exceeds the concentrations of the radioactive fission products. Removal of these bulk electrolytes and concentration of the resulting fission product solution are frequently involved in processes suggested for the disposal of radioactive wastes.

In a process for ultimate disposal proposed by Hatch and co-workers at Brookhaven, the bulk electrolytes must be removed prior to cationic sorption of the fission products in beds of ion exchange material. Presence of large concentrations of bulk electrolytes tends to decrease the fission products sorption. Hatch suggested electrodeionization, among other techniques, for the removal of bulk electrolyte.

A study using ion transfer membranes in the electrodeionization of solutions of nitric acid and aluminum nitrate has been carried out to provide information for evaluation and design of this step. Results of laboratory-scale tests are discussed here.

The membranes used consisted of anion exchange resin containing tertiary and quaternary ammonium groups. The membrane, spacers, and electrodes were sandwiched between rigid PVC blocks, and bolted together between stainless steel plates.

Stability of the Membranes

Membranes on Dynel backings were found (after 90 days' immersion in 0.05, 2, and 8M nitric acid at room temperature and at 60° C.) not to have weakened, deteriorated physically, nor developed leaks, except in 8M nitric acid at 60° C., where one sample developed a small leak. A membrane on Orlon backing deteriorated in 8M nitric acid at 60° C. after only two days of immersion, and developed leaks after 90 days in all cases except in 0.05M acid at room temperature. The Dynel-backed membrane was rated as satisfactory for nitric acid.

No deterioration or leaks of either type of backing was found on immersion in 0.5 and 2M aluminum nitrate at room temperature and 60° C. for 8 days.

Membranes immersed in nitric and nitrate solutions were subjected to gamma radiation in the range of 10^6 to 10^9 roentgens from a Co-60 source, and high energy electrons (beta) from a particle accelerator. Membranes exposed to a dosage of 3×10^8 r. lost between 25 and 50% of their original ion exchange capacity and approximately doubled in electrical resistance, but were still physically rugged enough to be used in cells. Significantly greater dosages (5.8×10^8 r. for gamma and 10^9 r. for beta) resulted in further loss of capacity and increased resistance, and the membranes became too stiff and brittle for use.

Ion Transfer Efficiency

The per cent removal of acid achieved in any given run was fixed experimentally by the relationships between the current density, flow rates, and current efficiency. A variety of operating conditions of anolyte and catholyte was studied to determine the characteristics of the system. The sensitivity of the anion transfer membrane to changes in the acid content of the anolyte was the largest effect noted. Comparison of the results of certain runs shows that an increase in the concentration of the catholyte caused a slight increase in the deacidi-

fication efficiency by increasing the amount of nitrate reduction in the catholyte relative to the evolution of hydrogen gas. However, an increase of the same magnitude in the concentration of acid in the anolyte resulted in a large decrease in the deacidification (and ion transfer) efficiency. The effect of variation in current density, over a twenty-fold range, was masked by changes in other variables.

Two- or Three-Compartment Cell

Although a two-compartment cell can be used to completely deacidify nitric acid waste streams, the reduction (as experienced) of nitrate to cationic nitrogen compounds (such as ammonia) which takes place in the system is undesirable in the preparation of radioactive wastes for ion exchange treatment in that these cationic species compete with the cationic fission products in the ion exchange step. The free ammonia formed could be stripped from the solution, but conversion of the fixed ammonia to free ammonia by transfer of the last traces of nitrate ion would be a very inefficient process. The cathodic reduction of nitrate ion and the formation of cationic nitrogen can be avoided by use of a three-compartment cell containing two anion transfer membranes. The second membrane separates the nitric acid waste stream from the cathode and permits transfer of hydroxyl ions into the central compartment from a solution of sodium hydroxide which is recirculated in the cathode.

The hydrogen ion of the waste nitric acid is neutralized by the transferred hydroxyl ions to form water, while the nitrate ions of the feed are transferred into the anode compartment. At the cathode, water is electrolyzed into hydrogen gas and hydroxyl ions, equivalent to the hydroxyl transferred from the cathode compartment into the central compartment. Thus, the make-up to the cathode and anode compartments is water. The nitric acid produced in the anode compartment can be recovered for reuse or sent to low level waste disposal.

The product of the single membrane cell provides a larger load on the ion absorption bed because of the residual cationic reduction products. The two-membrane cell has no residual cationic reduction products, but requires a greater membrane expense and a greater energy cost.

The bulk of the radioactive contaminants in the waste streams containing nitric acid consists of Ce, Sr, and other cations. (Radioactive Ru, however, may be present in both cationic and anionic forms.) To determine the decontamination factor to be expected on the cationic contaminants, the nitric acid feed in certain runs was made 0.02 N in Na. Flame tests of the anolyte product sensitive to 0.1 p.p.m. of Na were negative. A decontamination factor greater than 5×10^3 for cationic fission elements is indicated from this result.

Treatment of Aluminum Nitrate Solutions

The removal of aluminum nitrate by electrodialysis, carried out in same cell used in the nitric acid experiments, resulted in the formation of granular precipitates of hydrous aluminum oxide in the initial stages of denitrations, followed by the formation of the characteristic sticky, gelatinous aluminum hydroxide precipitate in the latter stages of the denitration. When the denitration was only 50 to 80% completed, the electrical resistance of the cell increased considerably during the experiments due to adherence of precipitate to the cathode. A number of factors were found to affect the nature of the precipitate and the degree of precipitation. Among these were: (a) current density, (b) concentration of aluminum nitrate, (c) temperature and, (d) nature of the cathode materials.

Condensed from a paper, "Treatment of Radioactive Wastes Using Ion Transfer Membranes: Removal of Bulk Electrolytes," by E. A. Mason, E. J. Parsi, and A. J. Giuffrida, to be presented at the Chicago Nuclear Congress.

New wrinkles in remote-controlled equipment

Practical experience in a remote-operated aqueous-type fission product separations plant has led to advances in the design of flow generation, measurement, and control systems.

Need for long life in corrosive and radioactive service has resulted in a new concept in bearing design which may have wide repercussions in other chemical engineering applications. Disregarding the time-honored assumption that bearing materials should permit the embedding of solid particles in the bearings themselves, bearings for regenerative turbine pumps were fabricated of boron carbide, a material hard enough to crush or grind foreign particles without damage to the bearings themselves. Results have been excellent; problems arising from the new design have in general been satisfactorily resolved. For example, since the new material cannot be installed by the usual shrink or press-fit methods, new ways of retaining the sleeve bearings in the housing were developed. To provide resistance to galling, scoring, and abrasion, Stellite, a cobalt-nickel-tungsten alloy, was used to apply a hard, corrosion-resistant facing on stainless steel shafts. The mating faces of the mechanical shaft seals were also of boron carbide.

Condensed from AEC Research and Development Report HW-49545A, "Flow Generation, Measurement, and Control," by J. Dunn and H. M. Jones, Hanford Atomic Products Operation, General Electric Co., to be presented at Chicago Nuclear Congress.

Splined Assembly

In remote operation, the standard practice of attaching the impellers of deepwell turbine pumps to their shafts has proved unsatisfactory. The drive or draw-in collets loosened as corrosion of the shafts and collets progressed. A new method of splined assembly was worked out to provide positive locking. Spacers, used to locate the impellers axially on the shafts, served two purposes: they acted as easily replaceable shaft journals, and served to position the impellers. A precipitation hardenable type of austenitic stainless steel was employed as sleeve material. Bowl assembly was simplified by use of external tie-bolts instead of individual cap screws for joining the bowl sections. In addition, improvement of casting techniques was effective in increasing over-all pump efficiency by two or three per cent by providing smoother internal surfaces.

Magnetic Flow Measurement

Various types of rotameter, in particular the electronic variety, have been used successfully in remote-control operations. However, the authors believe that the magnetic flowmeter, operating on the principle of Faraday's law, has characteristics which make it superior to the rotameter in many applications.

pilot plant development of a POLYETHYLENE PROCESS

M. R. Cines, G. H. Dale, E. W. Mellow and R. E. Weis | Phillips Petroleum Company,* Bartlesville, Oklahoma

A case history is highlighted of an accelerated pilot plant development program to commercialize a major new chemical process for polyethylene production.

Here is a report on the commercialization progress of Phillips' Marlex 50 ‡ polyolefin process, the major decisions made, and the basis for making them.† During a period of approximately three years a bench-scale process based on small batch reactor data was adapted to commercial equipment, many alternate process steps and equipment types were evaluated, design data were obtained, basic improvements resulting from continued research activities were incorporated from time to time, some operating personnel were trained in the pilot plants, a total of about 430,000 lb. of this polyethylene was produced for experimental and market development requirements, technical personnel were made available for plant start-up assistance, and pilot plant studies were conducted to solve some plant start-up problems.

After the first major decision, namely that the development should be undertaken, the company proceeded toward commercialization of Marlex 50 on the basis of well-developed research work. By that time, evaluation of laboratory and bench-scale research on ethylene polymers had led to the conclusion that a new and superior product could be made, that the probability of being able to scale the process up to an operable commercial plant was high, and that the project would be economically attractive. First objective was to build a semicommercial plant to test the commercial feasibility of the process and provide market evaluation quantities of polymer. Much of this work was assigned to Process Development Division of Research and Development Department.

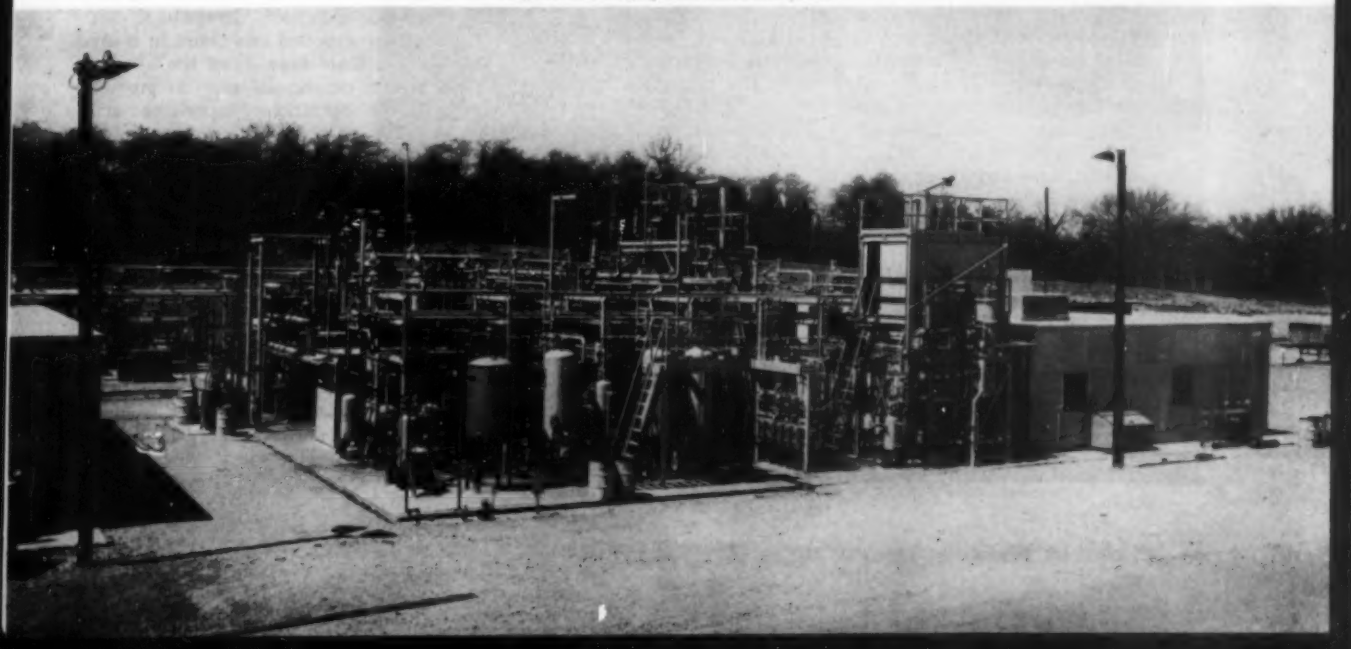
To achieve the initial objective set by management, it was necessary to obtain sufficient pilot plant data for the design of the semicommercial plant in about four months. At this point it should be noted that many new process steps were involved. Polymerization of ethylene takes place in a hydrocarbon solution in a stirred reactor with the aid of a suspended catalyst, chromium oxide on silica-alumina base. The catalyst is removed, polymer is recovered from the solvent, dried, and pelleted. Since the process divides into three major steps, three pilot plant groups were initially organized to develop the reaction step, catalyst removal, and polymer recovery. Further, several basic premises were set to guide the program: (1) it was agreed that the prime goal was a workable process with reasonable economics. Development of optimum economics would follow; (2) since there was an unwillingness to become involved in design of special mechanical equipment, commercially available equipment would be employed if at all possible; (3) parallel approaches would be followed simultaneously; (4) to expedite this type of program, special

* Research and Development Department, Process Development Division.

† Many process details which are confidential are not discussed here.

‡ Trademark for Phillips' family of olefin polymers.

Fig. 5. Marlex polyolefin semiworks plant.



process equipment would be borrowed or rented for rapid testing in the pilot units. For drying and pelleting, that last premise was modified to take small lots of material to equipment manufacturers' laboratories.

Early Reactor Development

Design and construction of a 20-gal. continuous reactor installation started immediately. Concurrently batch operation of an existing 10-gal. reactor showed that by a scale-up by a factor of 20 the same product could be made. These runs were continued for six weeks, until the 20-gal. continuous reactor was ready for use. Within two months, successful continuous operation of this reactor for periods of 24 to 48 hr. had been achieved. Mechanical difficulties were numerous and frequent plugging of polymer lines prevented more sustained reactor operation. These problems plus scale-up of mixing and heat transfer were then the heart of the reactor development program.

Figure 1 shows the Research Division's bench-scale batch reactor. This was the starting point for the pilot plant work. Figure 2 is an aerial view of Phillips Research Center in Bartlesville, Oklahoma, where both research and pilot plant work was done. The pilot plant area is in the foreground and the new Chemical Research Laboratory in the background. A view of one side of the first Marlex polyethylene pilot plant is shown in Figure 3.

Catalyst Removal and Polymer Recovery

While the first reactor development work was taking place, the groups concerned with catalyst removal and polymer recovery had installed equipment to evaluate the several alternate methods which appeared most promising for the type of solution involved. Initial test work proceeded at such times as satisfactory reactor runs provided a suitable feed stream. The quantities produced were dried in a vacuum tray dryer and chopped to provide material for evaluating properties of finished product. Through all stages of the project this finished product evaluation by the Research Division continued.

Through the next two months several periods of continuous pilot plant operation as long as six days were achieved. Some process steps were by then standardized while a few problems still remained. A month later a major process improvement was effected with a change in the hydrocarbon solvent. This was based on research data showing improved solubility and in practice greatly decreased difficulties from plugging process lines, thus improving continuous operation.

Production for Market Evaluation

By the original timetable the time was past when it was hoped to have process design information for a semicommercial plant. There were also one or two major processing problems and several steps appeared to need more experimental data. However, a pilot plant now did exist in which accumulating design data could be continued and, with little further investment, a reasonable amount of finished Marlex 50 polyethylene could be produced by brute force. Although this production was much less than anticipated from a semicommercial plant, it could become available much sooner and this fact appeared attractive. It was decided therefore that this experimental unit should be converted to a production unit, the semicommercial plant eliminated as a step in determining commercial feasibility, and a new group organized to undertake small-scale experimental work on individual process steps in other locations.

Eight months after the start of pilot plant work, selected production amounting to 600 lb., having properties within the narrow range considered to be most desirable for commercialization, was blended into one lot and made available for market evaluation. Market Development Division personnel distributed this material the following month to a number of plastics fabricators for small-scale production tests in their equipment. This was a slightly off-color material, described at the time as "light ivory," but otherwise it met all tentative specifications for Marlex 50 polyethylene. From this time on gradually increasing amounts of product were made available for market development.

At the close of the first year of pilot planting, process development had reached the stage where information was available for design of most steps of the process and for a reasonable estimate of construction and operating costs. The market evaluation reports were also promising. Assurances were given to management that although a number of scale-up problems still existed, acceptable solutions would be forthcoming. Building of a large ethylene plant at Phillips Petroleum Sweeny, Texas, refinery and of three Marlex polyolefin plants at its Adams Terminal installation at Pasadena, Texas, was approved by the Board of Directors the following month and design work on the first unit was started immediately. The size of the ethylene plant was later increased on the basis of additional markets for ethylene.

With the definite commitment to a commercial plant the objectives of pilot plant work became (1) to obtain sufficient technical information to make remaining major process decisions, (2) to supply design data to meet schedule of design freeze dates for individual sections of the plant over the next five months and, (3) to produce larger quantities of finished Marlex 50 polyethylene for market development purposes.

In line with the last-mentioned objective the pilot plant was put on a basis for long-term continuous operation. Drying, extrusion, and pelleting equipment was ordered to replace prior batch-finishing methods, tube trailers were ordered to provide for transportation of ethylene from the Gulf Coast in order to decrease high freight and handling expense on cylinder ethylene, and a 60-gal. reactor was built to increase plant capacity. By the time this reactor was being designed the commercial reactor design had already been finalized; thus, in this case, the pilot plant reactor was a scaled-down unit.

Semiworks Plant

Commercial design freeze dates were generally met, a few with some delay, and the first unit of the commercial plant was scheduled for completion late in 1956. Market Development Division needed large amounts of Marlex 50 polyethylene for use in the trade prior to availability of commercial production in order to achieve market acceptance of the plant output at that time. Even with the recent pilot plant expansion, facilities were inadequate to fill the needs of Market Development Division and still continue any process improvement studies. After consideration of various alternatives for expanding production, building a semiworks plant with capacity of 1,000 lb./day in Bartlesville was recommended. In addition to providing the required expanded production, the company expected this plant, in many ways a scale-down from the already designed commercial unit, to provide valuable operations experience and training, to serve as a demonstration unit for process licensees, to spread the risk of curtailment of production in case of fire, and to make the original pilot plant available for experimental purposes including further development of additional members of the Marlex polyolefin family.

EXPEDITING FOLLOWS APPROVAL

Management accepted the recommendation and approved construction of a semiworks plant of 1,000-lb./day capacity with the specification that it be completed within five months. The

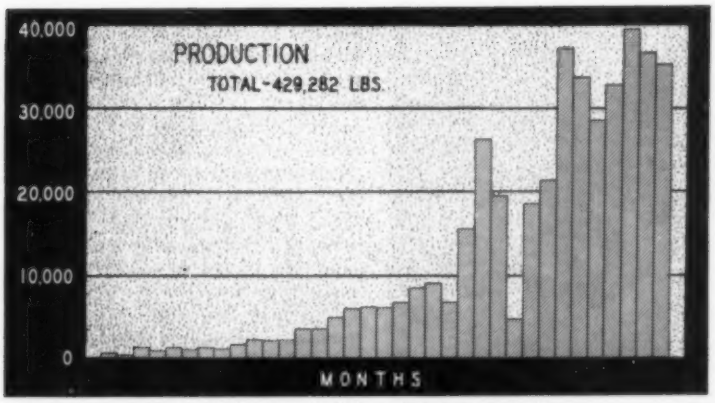


Fig. 6. Marlex 50 polyethylene pilot plant production.

Fig. 1. Bench-scale Marlex polyethylene reactor.

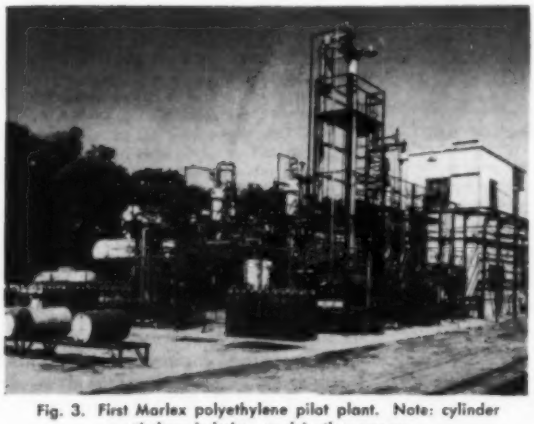


Fig. 3. First Marlex polyethylene pilot plant. Note: cylinder ethylene is being used in the process.

Fig. 4. Semiworks plant under construction.

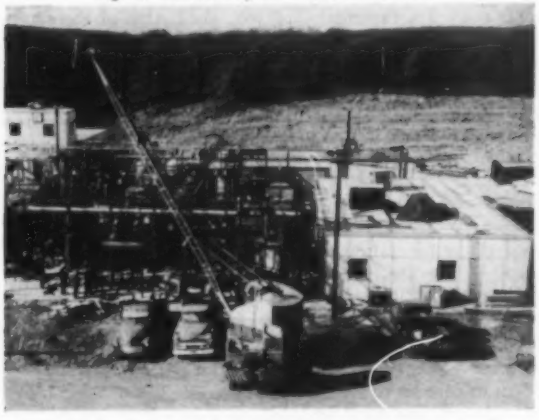


Fig. 2. Phillips research center in Bartlesville.

Fig. 7. Adams terminal Marlex polyethylene plant.

plant was to be designed and constructed by Phillips Engineering Department. To expedite this job, the engineering design group and two pilot plant liaison engineers were located at the plant site and design and construction proceeded simultaneously. Top priority was given to expediting equipment procurement. The plant was actually turned over to pilot plant personnel in four and one-half months from the date of authorization. Figure 4 is a view of the semiworks plant during construction. The completed plant is shown in Figure 5. Design rate of production was achieved in about two months. Except for a three-week shutdown to convert to an alternate process of polymer recovery, this plant was operated continuously for over a year, producing Marlex 50 polyethylene for market development use. Total production was 353,000 lb. At that time commercial production was available and the semiworks plant had completed its job in so far as the Marlex 50 polyethylene development was concerned. The bar graph in Figure 6 shows the total monthly pilot plant production of Marlex 50 polyethylene for the duration of the project.

Commercial Plant Construction and Start-up

Actual construction of the first unit of the commercial plant at Adams Terminal was begun on September 20, 1955. Initial operation of the plant began December 28, 1956. A start-up committee, consisting of key operating and process personnel of Phillips Chemical Company and representatives of the Research and Development Department, was organized and began functioning in November, 1956. Its purpose was to guide the start-up operations in such a way as to take full advantage of all the experience available within the company and to maintain continuous liaison between Research, Development, and Operations. The usual number of mechanical and minor process problems arose and additional personnel from Research and Process Development were made available for assistance at the plant as required. Only one major process problem was encountered and this was the subject of considerable pilot plant experimental work. In this case the actual plant revision required was minor and was effected in one day on a rush basis. Following this change design production of one line was achieved less than a week later, on March 29, 1957. Since that time, as with any process, Research and Development assistance is concerned with process improvements and with setting and maintaining and improving quality standards. These activities are decreasing with time but can be expected to continue to some extent indefinitely. Figure 7 shows an aerial view of the Adams Terminal installation with Plant I completed and Plant II, in the foreground, still under construction. The first shipment of finished product being loaded is shown in Figure 8. A sample of some consumer articles made of Marlex 50 polyethylene is illustrated in Figure 9.

Fig. 9. Marlex 50 polyethylene products.

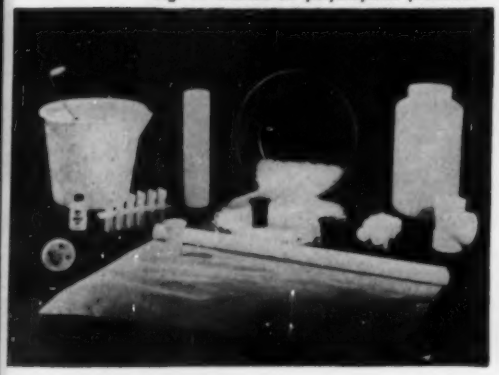


Fig. 8. First Marlex polyethylene shipment.

Manpower

TECHNICAL AND NONTECHNICAL COOPERATION

A final observation concerns the effective use of technical manpower in a rapidly expanding development program. The shortage of qualified technically trained personnel dictated spreading the engineering staff as thin as possible. Expansion was achieved by a modest increase in technical personnel along with a steady increase in the ratio of supporting nontechnical personnel.

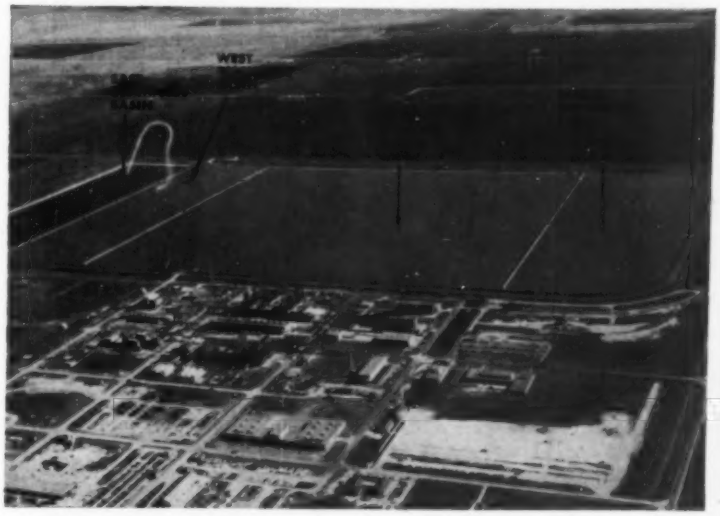
The progress in this direction is shown by the ratio of nontechnical to technical personnel in the pilot plant branch at various stages of the project. At the time Marlex 50 polyethylene pilot plant work started, this ratio was approximately 1.0. This was rapidly increased to 1.5 during early stages of reactor, catalyst removal, and polymer recovery development, and to 2.0 the following year as this work and some production for market evaluation continued. During the next year the ratio increased further to approximately 3.5, a level which now appears to be as high as the company can profitably go. This program has demonstrated that the maximum use of properly chosen nontechnical personnel can go far to relieve the shortage of technically trained personnel. Also it has been shown that the morale and effectiveness of both technical and nontechnical personnel are improved with resulting increase in level of responsibility assigned to both groups.

Presented at A.I.Ch.E. Annual Meeting, Chicago, Illinois.

History

The Seadrift plant of the Union Carbide Chemicals Company is located at its present site because Guadalupe River water was made available to it from state water permits owned by the Westside Calhoun County Navigation District. The original concept of operation of the water system was a once-through system with water returned for irrigation. Before the plant was built, a decision was made to install basins on the plant property to store a 4-day reserve of cooling water and a 90-day reserve of boiler feed water. Basins were also built to hold the cooling water return from the plant. These basins, designed for a 24-hr. return, were to be used for monitoring the water as a protection against crop damage before returning to the irrigation system. A weir with a movable gate was installed between the cooling water return basin and the cooling water storage basin. As a precaution against contamination of the effluent water by operating upsets during the plant start-up, operations were started on a recycle system.

One of these four basins is a 45-acre basin to retain low solids water for raw water for boiler feed treatment. The main cooling water basin is 139 acres. Adjacent to the cooling water basin are two 39-acre cooling water return basins. Figure 1 illustrates the basins, two of which are employed in the cooling cycle. Originally, it was planned that make-up water would be continually supplied at the canal lift station. The plant supply would enter at the intake structure on the north side of the cooling water basin and be discharged to the return structure. Either of the two discharge basins can receive return water. After being filled, one of the basins was to be tested and then dumped to the irrigation district for crop flooding while the other basin was being filled. On a closed cycle, the return water discharges into the west discharge basin and then spills over into the cooling water basin through a surface spill gate. This gate is located in the common dike wall. A constant depth of at least 8.5 ft. is maintained in the discharge basin.



POND SURFACE COOLING
for chemical plant cooling water

Cost of construction of pond surface cooling basins has been estimated to be one-third the amount required for purchase and erection of cooling towers calculated to produce similar results, assuming a land investment of $300 per acre.

R. L. Wright and D. E. Kirsopp | Union Carbide Chemicals Company,* Seadrift, Texas

The severe droughts of the summers of 1955 and 1956 made the recycle system of basins to store reserves of cooling water and of boiler feed water mandatory for operation by the Seadrift plant of Union Carbide Chemicals Co. The closed-cycle water system permitted operation during periods when make-up water was not available. Supply water from the basins thus was made available to the plant at temperatures that averaged 1.5° C. higher than forced draft cooling tower output, and 1.5 and 2° C. higher than river water. As the first year's drought extended into a second, it was deemed advisable to investigate the economics of cooling by the use of the natural cooling of these basins in contrast to the use of cooling towers. A test program was planned to determine the following:

- Conditions that control cooling
- Effect of basin level
- Efficiency of cooling
- Some aspects of design
- Cost comparisons for existing plant
- Basin supply temperature vs. river and cooling tower temperatures
- Operating costs.

The test entailed operating the water system on a closed cycle with no make-up from June 20 to August 3, 1956 (50 days). Cooling was accomplished in the 39-acre receiving basin and the 139-acre storage basin. A total of 14.3×10^9 B.t.u./day was dissipated in this manner. Flows of 80,000 gal./min., requiring a minimum temperature of 8.3° C., were the conditions required of the system. During the 50-day period, the basin level was reduced from the initial depth of 8.9 ft. to a final depth of 3.9 ft.

It has been calculated that from 50 to 60% of this cooling was effected by evaporation with the remaining amount being removed by sensible heat transfer. Total heat transfer varied directly with wind velocity. Cooling

* A division of Union Carbide Corporation.

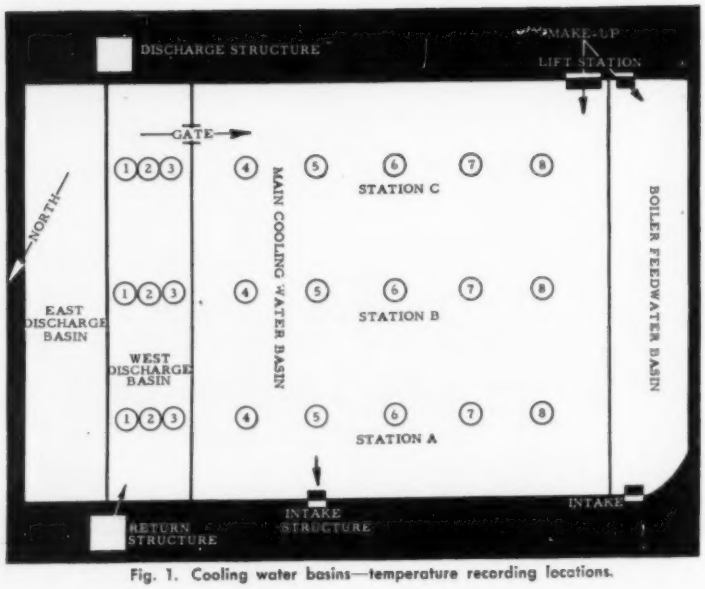


Fig. 1. Cooling water basins—temperature recording locations.

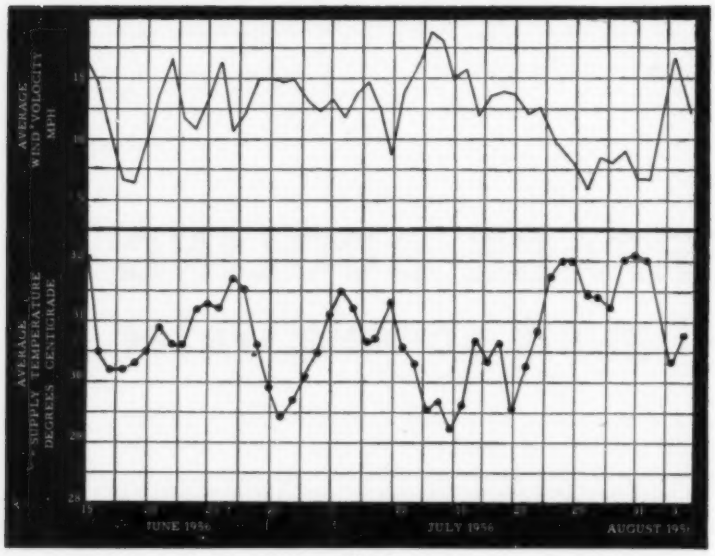


Fig. 2.

was more influenced by wind than humidity. Water temperatures varied 4° C. in 24 hr. at 4.0-ft. depth and 2.5° C. at 8-ft. depth. There were no significant channels of warm water nor appreciable stratification detected during operation at normal levels.

Any tendencies towards inadequate cooling or channeling could ultimately make the closed cycle inoperative by reducing the capacity with each turnover of the contained volume. A secondary purpose of the test was to detect any indication of such tendencies. To accomplish this, sample points were established throughout the main basin and the west discharge basin. Any channel formation could be detected by determining and charting water temperatures at these points. Simultaneously, the area in the basins producing the greatest cooling and the areas of low efficiency could be located. Some 48 sampling trips on the basins were made during the test.

Conditions observed and recorded in the attempt to determine factors controlling cooling in the basins were as follows: (1) atmospheric temperatures, (2) relative humidity, (3) wind velocity, (4) time of day (solar effect), (5) depth of pool. Most of these conditions vary over an area as large as the basins. The analytical data were not exacting for this reason, but trends and changes could be observed. Sufficient information is available for conclusions, and the test results based on trends are presented.

1. Conditions That Control Cooling

It was to be anticipated that lag periods arising from the large volumes involved would follow any major atmospheric changes. Actual results indicated changes from one day to the next with no change of heat load delivered to the basin. Some changes were detected within a period of hours. Extreme conditions gave indications of the major control factors.

For example, the results of a basin test run the afternoon of July 31, compared to a similar one made the morning of August 1, are indicative of an overnight change. The maximum supply temperature from the main basin on the earlier day was 34.6° C., the minimum temperature was 32.8° C. The next day, the maximum temperature had dropped to 32.9° C. and the maximum to 30.5° C. The average wind velocity for the July 31 test was 6.8 miles/hr.; for August 1 it was 12.2. On days with wind velocity around 15 miles/hr. and above, supply temperatures of 30° C. or less were attainable. Figure 2 illustrates the effect that wind velocity has in controlling basin cooling. Figure 4 indicates that the effect of humidity is not as apparent and also shows that the temperature of the supply water was within 5° C. of the wet-bulb temperature.

The solar evaporation rate in the basins was determined by using the adjacent boiler feed basin as a control. During the 50-day test period, a total of 13 in. of water, based on metered usage vs. volume loss, evaporated from the surface of this basin. This evaporation was closely substantiated by calculation of dissolved solid concentrations. Apparently, the seepage loss over the period was negligible. There was no make-up, no return, no rain during this period. A similar solar evaporation loss was assumed in the cooling water basins. This loss was independent of the induced heat from the plant because the same quantity of solar heat must be dissipated for any given time and area.

For calculation purposes certain basic assumptions are given in Table 1.

The level in the west discharge basin remained constant because of the surface spill over into the main basin.

Table 1.—Assumptions for Calculation Purposes

Pumping rate - gal./min.	80,000
ΔT, between process water inlet and outlet, ° C.	8.3
B.t.u./lb. H_2O evaporated	1,000
Gal./in. level of main basin	3,780,000
Gal./in. level of west discharge basin	1,061,000
Area main basin, acres	139
Area west discharge basin, acres	39
Plant water usage, gal./min.	1,600
Test length, days	50
Loss by solar evaporation from main basin and west discharge basin: 13 in. (based on boiler feed basin)	
× (3,780,000 + 1,061,000) = 62,800,000 gal.	

Therefore, the 62,800,000-gal. loss was apparent only in the main basin, and is equivalent to 16.6 in. loss in level in that basin. Inplant consumption of 1,600 gal./min. accounted for 30.5 in. equivalent loss in level of the main basin. Had all of the cooling been effected by solar evaporation, an additional water loss of 86,000,000 gal. by evaporation would have resulted. This is equivalent to 22.7-in. loss in level of the main basin.

Actual losses observed during the test were 60 in. Maximum theoretical losses would have been the sum of solar evaporation, inplant consumption, and additional loss if all cooling were by solar evaporation, or 69.8 in. By subtracting these, a direct comparison can be made to cooling by evaporation and by other means. Since the solar evaporation rate could be calculated and the plant usage could be determined, these volume losses were fixed. The difference of 9.8 in. retained in the basin represents water that did not have to be evaporated from the system to meet its cooling requirements.

The 22.7 in. loss (just referred to) is directly related to the British thermal unit loss from the cooling water during a pass through the basins. The heat loss by evaporation is seen to be the difference between the 22.7 total theoretical and 9.8 residual inches, expressed as percentage of the former, or 56.8% heat loss by evaporation.

As heat loss by evaporation accounts for only 50 to 60% of the total, this can be seen to minimize the importance of possible errors in metering and evaporation calculations.

The variation of the supply temperature over a 24-hr. period is further evidence of sensible heat transfer, Figure 3. The wet-bulb temperature varied only about three or four degrees over a full day. However, the ambient temperature varied as much as 20° F. Also, with the increase in wind velocity during the evenings and early morning, the surface air change-out rate was rapid. The air-water temperature differential remained at a maximum. For this particular day, the maximum cooling resulted during periods of the highest relative humidity.

2. *Effect of Basin Level*

As the level dropped, as might be expected the stratification temperature differentials lessened and then disappeared in the final stages. Basin volume responded faster to the wind, sun, and ambient temperatures. On occasions, the supply water temperatures ranged from 30.5° C. in predawn to 34° C. in mid-afternoon. The east discharge basin, full during the tests and with no heat added other than solar, had a fluctuation in temperature of less than 1° C. over the same period. The boiler feed basin, also at low level and carrying no recycle water, followed the wide variation pattern of the cooling water basin. Even though lower temperatures occurred in a shallow basin at nights, the results of high daytime temperatures more than offset the lower nighttime temperatures.

It was not until the basin level had dropped to nearly 4 ft. that any significant channeling occurred. At this time, there appeared a flow of water that followed the south bank of the main basin to the west bank. The flow progressed along the west bank to the north bank and then into the intake structure. One of the reasons for the directional flow is that the ratio of the return volume to the depth of the basin had increased. A downward velocity developed across the recycle gate. Eventually the return water had overcome the inertia and started a channel. Bank wash offers another explanation of this pattern. During the early operation of the basins, no concrete liner was in place. The dirt that washed from the dike dropped out of suspension some 200 to 300 ft. from the bank, similar to the formation of a sand bar. A natural channel was formed. However, the actual path was affected by the wind velocity. During the later stages of the test work, there was an indication that the center of the basin had become stagnant and was no longer effective in the cooling capacity of the basins.

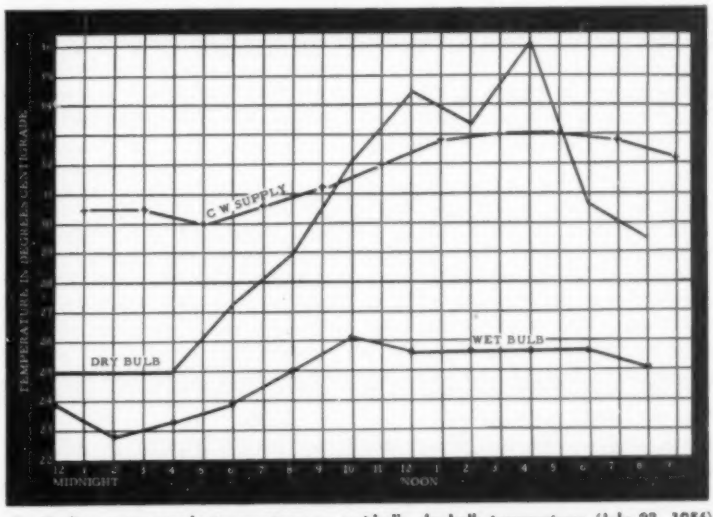


Fig. 3. Cooling water supply temperatures vs. wet-bulb, dry-bulb temperature (July 23, 1956).

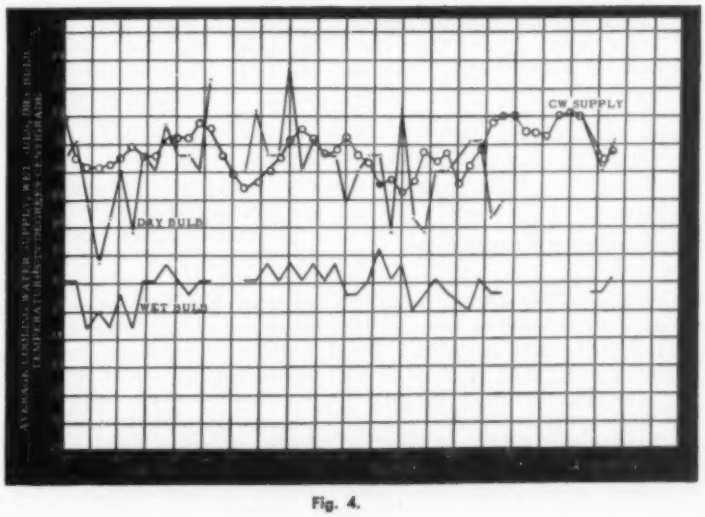


Fig. 4.

3. Efficiency of Cooling

During the test period, heat loading to the basins amounted to 596,000,000 B.t.u./hr. As the total effective basin area is 7,531,796 sq.ft., this corresponds to an over-all heat loss of 79.5 B.t.u./(sq. ft.)/(hr.). Temperature data indicated that a large proportion of this loss occurred in the small discharge basin. The heat drop in the small basin varied from a 5.3° C. drop to a 2.2° C. drop. On an area basis, this represented a range of 285 B.t.u./(sq.ft.)/(hr.) to 107.0 B.t.u./(sq.ft.)/(hr.). For the test period, there was an average drop of 183 Bt.u./(sq.ft.)/(hr.) in this smaller basin. The factors believed to have caused the difference between the maximum and minimum days were the wind velocity and the relative humidity.

4. Some Aspects of Design

The retention time necessary for cooling and the reserve storage volume are the principal considerations in basin design. Conditions at Seadrift indicated that an operating depth of from 8 to 9 ft. to be about optimum. No channel formation of consequence was noted at these depths. The desired cooling was effected and the wide fluctuation of temperature of the supply water was dampened. The spill-over-type weir for recycle is considered the most reliable because the warm water from the small basin spreads over the top of the cooler water in the large basin similar to oil depositing on a surface.

The basins described were fabricated from soil within the basin area. After a 6-in. topsoil skim, the subsoil was considered acceptable for dike construction. Soil borings were made throughout the area. This procedure indicated that a plastic-type clay existed. No bottom treatment was necessary. Soil porosity and consistency will affect the cost of any basin construction. If such an undertaking is considered, a thorough preconstruction engineering study can determine whether local soil can be used. If dike and bottom material must be hauled in, a reevaluation should be made.

5. Cost Comparisons for Existing Plant

To accomplish the same cooling achieved in the 50-day tests in cooling towers, a ground area of about 32,000 to 35,000 sq.ft. would be required. The height would have to be about 35 ft. Fan horsepower would be near 1,300 bhp. A construction comparison of approximately $1,800,000 for cooling towers, less pumps, and $653,400 for the basins, including land, shows pond surface cooling the more economical method if an approach to the wet-bulb temperature of 4 to 8° C. is sufficient for supply water.

6. Basin Supply Temperatures vs. River and Cooling Tower Temperatures—Comparisons for Future Expansion

At the time this test was run, there was no choice but to operate the plant cooling water system at the temperatures made available by the basins. In anticipation of expansion in the plant and the recovery of the volume of the river's flow, the question had to be answered as to what type cooling should be employed in the future. Which of the following should be used for expansion?

1. Install cooling towers
2. Return to a once-through system
3. Expand the reservoir-basin system.

Analysis of proposal No. 1 is based on a comparison of water supply temperatures during the basin test to a small process water cooling tower located in the plant. For the 50-day period the basin supply temperatures averaged 1.5° C. higher than supply temperature from the process cooling towers.

To install a bank of cooling towers which would result in temperatures that average 1.5° C. lower, additional horsepower must be provided to increase the cooling water return pressure since an additional 40 ft. of head must be developed. A further increase in horsepower would be required for forced draft fan drive. To develop additional 40 ft. of head (65% efficiency) 1,250 hp. is required and for forced draft fan drive 1,300 hp. is required or a total of 2,550 bhp.

The basin supply temperature averaged between 1.5 and 2.0° C. higher than that of the water coming directly from the river. If water had been available, it would have required an additional 1,200 bhp. to pump continually into the basin system, this assuming the cooler water is available. This additional horsepower is necessary to lift the water from the lower river level and also to circulate the water in the basin to promote cooling and prevent stagnation.

Observation of the temperature of the adjacent boiler feed basin indicated that the supply temperature would not have been reduced by once-through operation. No heat was added to the boiler feed basin, yet the outlet temperature was within 0.5° C. of the plant cooling water supply. One explanation for this phenomenon is the shade and water hyacinth cover afforded the river. The use of shading devices has been considered, but they cut down too much on the wind, and hence hamper cooling. Marine life for casting shade has also been tried, but this blocks the wind and clogs up the system. Monomolecular films have also been tried and found unsatisfactory because they reduce evaporation too much for effective cooling. A direct, low-residence time canal to the plant would have been required to obtain the lower temperature.

These facts supported a cooling water expansion program by basin enlargement.

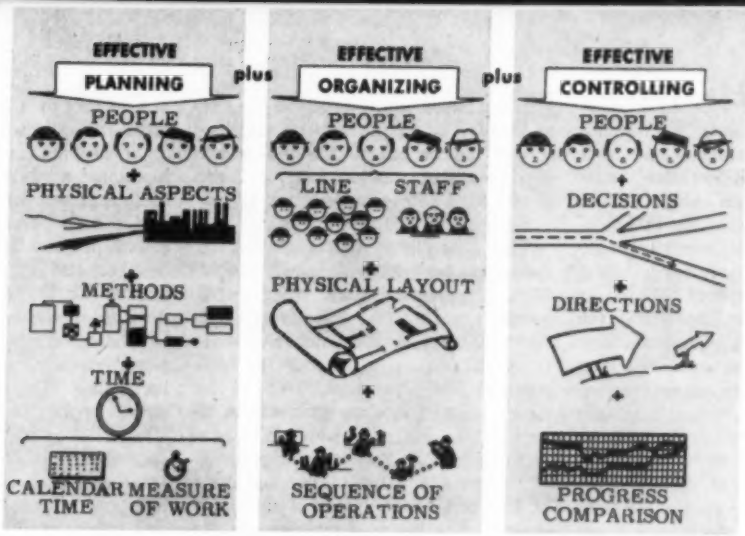
7. Operating Costs

Solids concentrations for the 50-day period were 1.3 times. Excessive scale laydown or corrosive properties were not encountered at this level. Dissolved oxygen ranged from 4.0 p.p.m. on warm days to 6.0 p.p.m. on cold days. This value is less than is found in cooling towers and reduces the corrosion rates. If sufficient make-up water is available, chlorination for algae and slime control will be the only treatment cost. The annual operating cost is $1,825 for chlorination and $3,000 for basin wall repair. These costs compare with cooling tower costs of $73,000 for chemical treatment, $60,000 power cost for developing an additional 40-ft. head, and $30,000 for maintenance. (In each case, the power to pump water from the tower river level 9 ft. to the basin has not been added since that is constant for each and cancels out.) The 4% per pass loss encountered during the test period could be further reduced by reuse of in-plant consumed water. Also, the period that the test was undertaken was intentionally one of high solar evaporation. On a 12-month basis, the over-all loss should be less than that for a cooling tower because of lower evaporation in the wintertime and the continual make-up by rain.

CORRECTION

In the article titled "Effects of Gaseous Detonations Upon Vessels and Piping," by Randall, Bland, Dudley, and Jacobs (*CEP*, December, 1957, p. 574), the first sentence in the introductory head refers to "the explosion which destroyed the refinery at Whiting." This is incorrect because the explosion destroyed only one refinery unit, the fluid hydroformer, a relatively small part of the total refinery. The sentence should read, "This article represents work done in investigating the explosion which destroyed a refinery unit at Whiting, Indiana (described by Jacobs, *et al*, in the preceding article)."

Fig. 1.



EFFECTIVE MAINTENANCE

F. D. Macy | Shell Oil Company, Houston, Texas

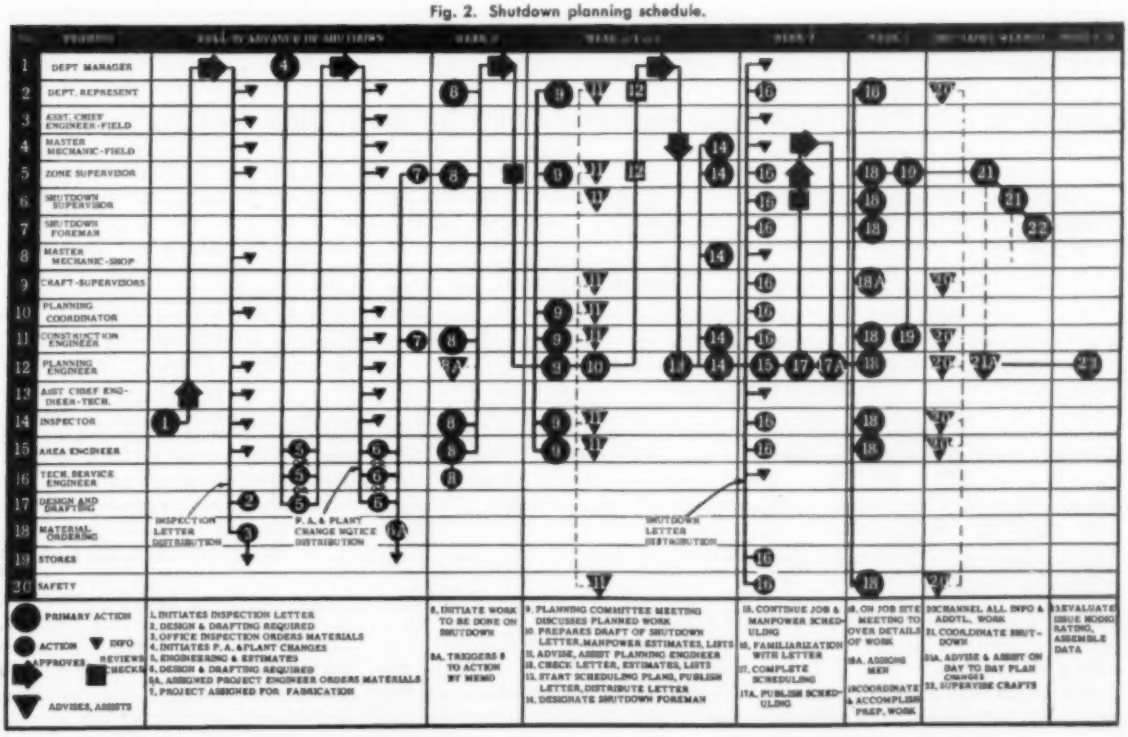
An effective maintenance system is the summation of effective plans, effective organization, and effective control. Unfortunately these are not independent variables. However, because of their very nature, we have to treat them as such and hope the interaction effect is favorable.

Planning is an essential requirement of successful maintenance as it must implicate people, being an exercise in creative thinking. But thinking about what? Naturally, it is the thinking about what is to be done, how it is to be done, and when.

What is to be done involves the physical aspects of the job, the equipment that is to be worked on and its condition, the materials that are needed, and the methods that are to be employed.

When it is to be done concerns time. This time, however, must be considered not only as calendar time but also as measurement or a yardstick of work. If there is to be effective planning, this measure is a very important, in fact critical, element in the effort. In the absence of a more exact measure, the usual practice is to be satisfied with a guess or estimate. An estimate

Fig. 2. Shutdown planning schedule.


1 DEPT MANAGER
2 DEPT. REPRESENT
3 ASST. CHIEF ENGINEER-FIELD
4 MASTER MECHANIC-FIELD
5 ZONE SUPERVISOR
6 SHUTDOWN SUPERVISOR
7 SHUTDOWN FOREMAN
8 MASTER MECHANIC-SHOP
9 CRAFT-SUPERVISORS
10 PLANNING COORDINATOR
11 CONSTRUCTION ENGINEER
12 PLANNING ENGINEER
13 ASST CHIEF ENGINEER-TECH.
14 INSPECTOR
15 AREA ENGINEER
16 TECH. SERVICE ENGINEER
17 DESIGN AND DRAFTING
18 MATERIAL ORDERING
19 STORES
20 SAFETY
INSPECTION LETTER DISTRIBUTION
P. A. & PLANT CHANGE NOTICE DISTRIBUTION
SHUTDOWN LETTER DISTRIBUTION
PRIMARY ACTION
ACTION
INFO
APPROVES
REVIEWS CHECKS
ADVISES, ASSISTS
1. INITIATES INSPECTION LETTER
2. DESIGN & DRAFTING REQUIRED
3. OFFICE INSPECTION ORDERS MATERIALS
4. INITIATES P. A. & PLANT CHANGES
5. ENGINEERING & ESTIMATES
6. DESIGN & DRAFTING REQUIRED
6A. ASSIGNED PROJECT ENGINEER ORDERS MATERIALS
7. PROJECT ASSIGNED FOR FABRICATION
8. INITIATE WORK TO BE DONE ON SHUTDOWN
8A. TRIGGERS 8 TO ACTION BY MEMO
9. PLANNING COMMITTEE MEETING DISCUSSES PLANNED WORK
10 PREPARES DRAFT OF SHUTDOWN LETTER, MANPOWER ESTIMATES, LISTS
11. ADVISE, ASSIST PLANNING ENGINEER
12. CHECK LETTER, ESTIMATES, LISTS
13. START SCHEDULING PLANS, PUBLISH LETTER, DISTRIBUTE LETTER
14. DESIGNATE SHUTDOWN FOREMAN
15. CONTINUE JOB & MANPOWER SCHEDULING
16. FAMILIARIZATION WITH LETTER
17. COMPLETE SCHEDULING
17A. PUBLISH SCHEDULING
18. ON JOB SITE MEETING TO GIVE DETAILS OF WORK
18A. ASSIGNS MEN
19. COORDINATE & ACCOMPLISH PREP. WORK
DISCHANNEL ALL INFO & ADDTL. WORK
21. COORDINATE SHUTDOWN
21A. ADVISE & ASSIST ON DAY TO DAY PLAN CHANGES
22. SUPERVISE CRAFTS
23 EVALUATE ISSUE MONOGRATING, ASSEMBLE DATA

is a form of work measurement. Unfortunately, it is the lowest form by the very nature of its definition, although it is the cheapest and most frequently used. By definition, to estimate is to form a general opinion, a valuation based on opinion or roughly made from imperfect or incomplete data. The broader the scope of the job to be estimated, the less dependable the estimate is. This lack of dependability can be offset by experience, but then the experienced estimator is pulling from a reservoir of standard data, and the defined term no longer applies.

The organizing function also involves people. Some of them are the same people who were used in the planning function. The additions are supervisors who will be in direct line of command. The key is to select people who can and will carry out the job

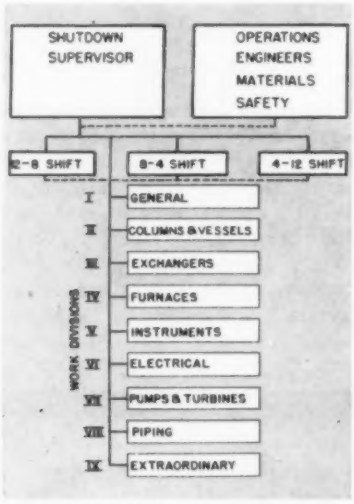


Fig. 5. Shutdown organization.

according to the created plans. One problem is to overcome the old bugaboo of craft supervision vs. job supervision and the number of supervisors needed. It would be next to impossible, because of the complexities and magnitude of the work and around-the-clock activities required during a refinery unit shutdown, to supply each craft on each shift supervision that has been trained and experienced within the craft. At some place in the growth cycle of a refinery or chemical plant, an area is entered that makes strict craft supervision impractical and job supervision, or a combination of both types, the only feasible solution. This requires an education phase when new concepts are introduced to the line supervisors who in turn must assist in selling the craftsmen.

But organizing takes into account more than just *people*. Other factors are: the physical layout of the job site to be sure that power, tools, and materials can be fed to the job where needed without undue loss, and the sequence of job operations for proper assignment of craftsmen.

The controlling function, that is, the action part definitely needs people. Here it will soon show whether the ground work was effectively laid. Here is the time for quick and well-founded decisions to be made by both line and staff personnel. Here is the time for definite, clear instructions to be given to craftsmen who are to perform the work. But something else is of importance. Due to the multitude of jobs to be done around a unit shutdown and to the need for many crafts working individually, yet as a team, to get many of these jobs done, it is impossible for any person to carry in his mind an imprint of the planned schedule and make a progress report on every job. To have effective control, there must be a tool for comparing at reasonable intervals the actual progress with the planned and scheduled progress. A restatement of the theory is given in Figure 1.

To explain the application of scientific planning, organizing, and controlling without going into a great deal of detail is difficult. It is best illustrated by a flow diagram as shown in Figure 2. The left-hand column lists the people involved in the planning and execution of any shutdown. It includes the equipment owners, that is, the operating department personnel, who authorize the work to be done; the line supervisors through whom the information must flow and who, in the end, are responsible for effecting the assignment; the staff specialists who assist in the coordination, investigations, and recommendations; and finally, those responsible for design, material supplies, and safety permits. Across the bottom of the chart the functions and responsibilities of the personnel are highlighted. Across the top of the chart is a time schedule showing the time by which each activity must be completed.

Occasionally, when new tools, devices, or techniques are being introduced, it is advisable to diagram the flow of such procedure. Figures 3 and 4 illustrate a typical job method and layout for a shutdown job. The particular illustrations are for the unloading and reloading of catalyst for Platformer reactors. During this shutdown a completely new system for catalyst handling was introduced. This change reduced the time substantially. The catalyst change time is no longer the limiting factor for shutdowns on this and similar units.

A picture of a typical shutdown line organization is seen in Figure 5. The organizational assignments take the functional approach. Depending upon the manpower demands for each function, the number of supervisors can be determined and the functions combined or separated according to these demands. This type of organization can draw upon the craft specialists to fill in where needed. It should be emphasized, however, that this illustration is incomplete. The formal organizational chart applicable to any shutdown should list by name the individuals responsible for each function as well as list the staff specialists who are available and responsible for their respective functions.

Finally, as an aid to sequential execution of any job, a work schedule is drawn, Figure 6. Illustrated in this figure is the unloading sequence during the catalyst change procedure. The job is broken into elements. The length of time and manpower requirements are determined. The schedule shows when each activity is expected to occur and what crafts are to be available at that time.

Although it is possible to schedule each job included in the whole shutdown, it is a tremendous task. From a practical standpoint, those jobs that should be scheduled in detail are the anticipated "bottleneck" jobs. Other work can be integrated with these schedules. Such schedules are not only useful in informing the supervisors who should be available and when, but also useful in indicating the progress of the job. Hereby exists a progress report available at any time to compare the actual status of the job with scheduled plans.

For years we have been satisfied to accept by "feel" that the job went well or sour. This feel is fairly dependable but it lacks a sense of realism and a measure of "how much." To instill a sense of realism, since no two shutdowns even on the same unit are the same, and to indicate how much of a change was made over the past shutdowns, the Houston refinery of Shell Oil has devised a rating report. All of the possible elements that could be measured during a shutdown were segregated and studied. The studies involved digging out the historical labor charges, a series of job observations, and an application of work-sampling techniques. From these results standards were derived for each element. Table 1 summarizes such elements. It is a simple matter, knowing what equipment is to be worked on during a shutdown and what to plan to assign standard values to these elements, to add the element

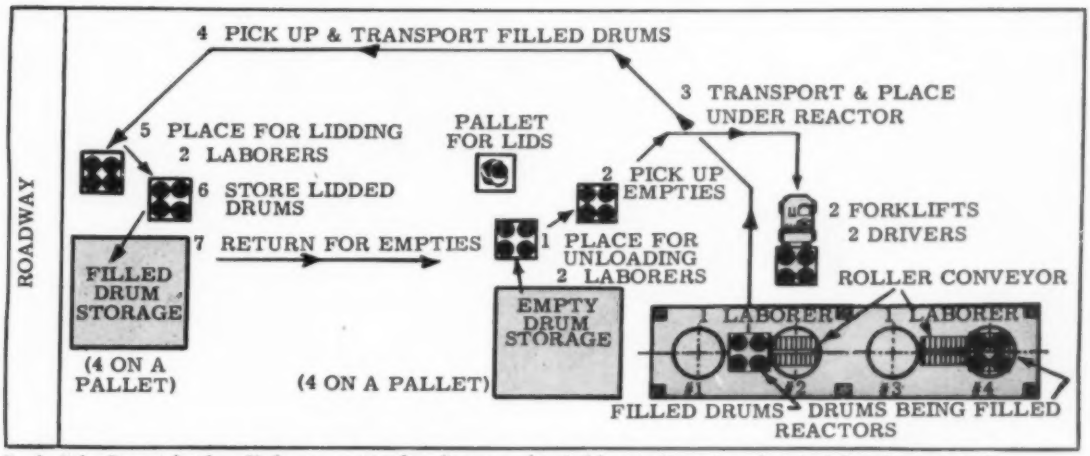


Fig. 3. Unloading catalyst from Platformer reactors: flow diagram and typical layout. Note: a) numbers in circles refer to operation sequence; b) filling operation cycle is 3 min. without delays; c) lidding and unlidding cycle is 3 min. without delay; d) transporting cycle is 3 min. without delay; e) manpower required—6 laborers, 2 fork lift drivers.

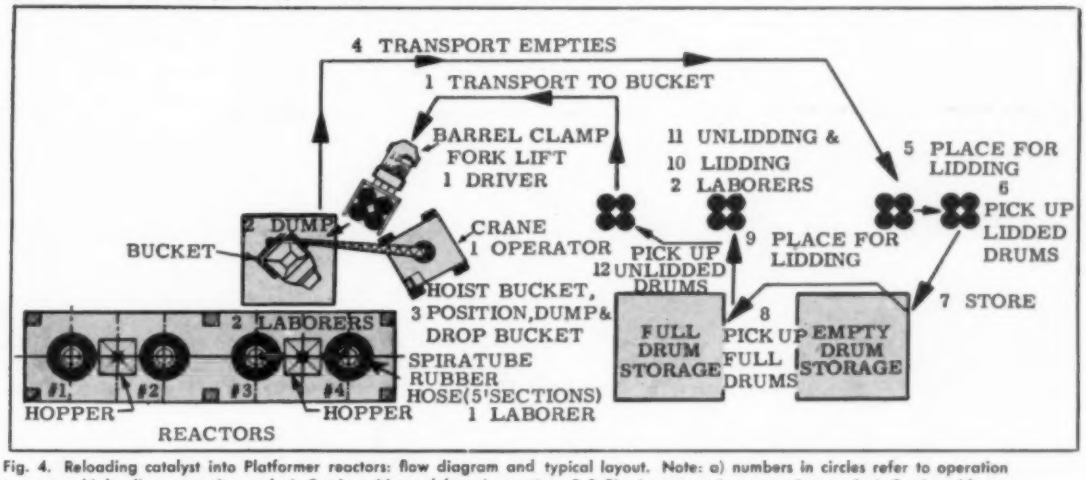
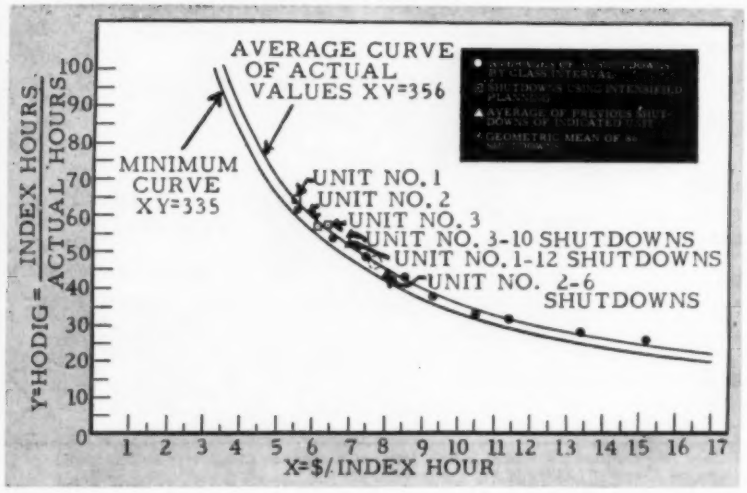


Fig. 4. Reloading catalyst into Platformer reactors: flow diagram and typical layout. Note: a) numbers in circles refer to operation sequence; b) loading operation cycle is 3 min. without delays (operations 2 & 3); c) transporting operations cycle is 3 min. without delays; d) lidding and unlidding cycle is 3 min. without delays; e) manpower required—6 laborers, 1 crane operator, 1 fork lift driver.

OPER. NO.	OPERATION	JOB HOURS	MANPOWER	EQUIPMENT	SCHEDULE (HOURS)
1	STORE EMPTY DRUMS ON SITE	4	4 LABORERS 1 TRUCK DRIVER 1 FORKLIFT DRIVER	1 FLATBED TRUCK 1 FORKLIFT	
2	STORE NEW CATALYST ON SITE	4	4 LABORERS 1 FORKLIFT DRIVER	1 BARREL CLAMP FORKLIFT	
3	HOT BOLT TOP & BOTTOM PIPING DETAILS	3	4 PIPEFITTERS 4 HELPERS		1A,2 3A,4 REACTOR NO.
4	REMOVE TOP & BOTTOM PIPING DETAILS, INSTALL WOODEN BLD. FLGS. AND CONNECT NITROGEN PURGE	4	2 PIPEFITTERS 2 HELPERS 1 CRANE OPERATOR 1 FORKLIFT DRIVER	1 CRANE 1 BARREL CLAMP FORKLIFT 2 CHAIN HOISTS	1A,2 2A,1
5	REMOVE BED PLATES	8	2 BOILERMAKERS 6 HELPERS	2 BOSUN'S CHAIRS 2 AIR RESPIRATORS 2 AIR HOISTS	1A,2 2A,1
6	INSTALL UNLOADING CHUTES AND PULL FOOT VALVES	2	2 PIPEFITTERS 2 HELPERS	2 UNLOADING CONES	1A,2 2A,1
7	UNLOAD CATALYST	6	8 LABORERS 2 FORKLIFT DRIVERS	2 FORKLIFTS 2 ROLLER CONVEYORS	1A,2 2A,1
8	INSPECT REACTORS	4	1 INSPECTOR 1 TECHNOLOGIST	2 AIR HOISTS 2 BOSUN'S CHAIRS	1A,2 2A,1
9	CONTINGENCY REPAIRS AND CLEANOUT	8	2 BOILERMAKERS 2 HELPERS 2 LABORERS	2 AIR HOISTS 2 BOSUN'S CHAIRS	8 HOURS TOTAL
	TOTAL		206 MANHOURS		NOTE: 1 OPERATION 5 EXTRA HELPERS REQUIRED TO MAINTAIN AIR SUPPLY TO BOILERMAKER IN REACTOR.

*NOT INCLUDED IN MANHOURS TOTAL

Fig. 6. Platformer #1 catalyst change schedule. Unloading schedule No. 1.


AVERAGE CURVE OF ACTUAL VALUES XY=356
MINIMUM CURVE XY=335
UNIT NO. 1
UNIT NO. 2
UNIT NO. 3
UNIT NO. 3-10 SHUTDOWNS
UNIT NO. 1-12 SHUTDOWNS
UNIT NO. 2-6 SHUTDOWNS
Y=HODIG = INDEX HOURS / ACTUAL HOURS
X=$/INDEX HOUR
0 10 20 30 40 50 60 70 80 90 100
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

◀ Fig. 7. Hodig rating vs. dollars/index hr.

values, and to arrive at a workload index. This index can in turn be compared with the actual labor hours expended. The ratio is an effectiveness rating which is termed the Hodig rating (How did it go?) to get away from any possible reference to an efficiency report.

With a measure of effectiveness a comparison can be made of shutdowns over a long period. Those shutdowns, where we know an extra effort has been expended for planning, where special attention has been given to the organization, and where effective control was exercised can be isolated.

Figure 7 shows an evaluation curve with three units being used to highlight the effect of extra effort. The horizontal axis represents the cost of getting the job done. It is expressed in units of dollars per workload index hour. The vertical axis is the Hodig rating, that is, the ratio of index hours to actual hours.

Once the Hodig rating is known, the curve will show the dollar cost per index hour. By way of example, the average cost of twelve shutdowns on Unit No. 1 has been $7.00/index hr. With extra effort expended on the three variables of the theorem, a recent shutdown cost $5.60/index hr. The difference is $1.40. If the total workload index for the shutdown is 4,000, the total savings in labor dollars over the average is $5,600. The savings on other units can be calculated similarly.

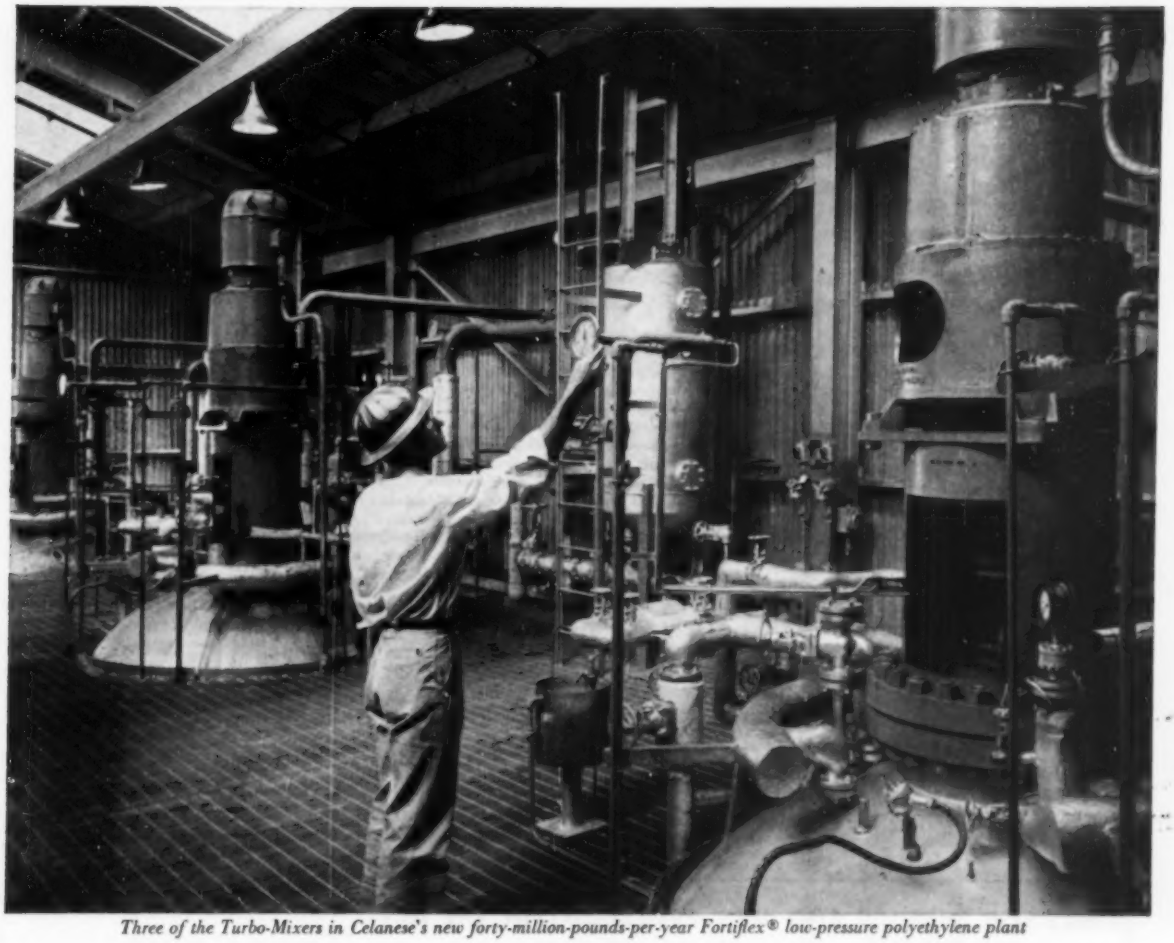
The evaluated results should be sufficient to establish the validity of the theorem.

Presented at meeting of South Texas Section, A.I.Ch.E., Galveston, Texas.

Table 1.—Job Standards

Unit		Columns				Vessels			Exchangers				Pumps	
		Clean	Inspect	Repair		Clean	Inspect	Repair	Clean	Inspect	Bundle		Check	Repair
				Minor	Major						Renew	Retube		
Crude	1	40	50	105	325	20	25	45	25	30	15	75	30	90
	2	40	50	105	325				25	30				
	3	20	40	105	325				25	30				
	4	40	160	105	600				40	60				
Crack	1	80	90	105	325		Per		40	60		Per		Per
	2	80	90	105	600				40	60				
	3	100	120	105	600		Vessel		40	60		Bundle		Pump
Gas	1	20	60	105	325				25	30				
	2	20	60	105	325				25	30				
	3	40	120	105	325				40	60				
	4	40	160	105	600				40	60				
Treat	1	40	60	105	325				25	40				
Lube	1	60	80	105	600				25	40				
	2	60	80	105	325				25	40				
	3	60	80	105	325				25	40				
	4	60	80	105	325				25	40				
	5	60	80	105	325				25	40				

		Furnaces				Drives	Pop Valves	Piping		Instru. Work	Elect. Work	Prep. & Clean
		Clean	Repair	Retube	Paint			Renew	Gen. wk.			
									%	%	%	%
Crude	1	175	50	25	50	40	10	25	32	7	1	5
	2	175	50			40		25	32	7	1	5
	3	120	50			40		25	32	7	1	5
	4	120	50	Per	Per	40	Per	50	26	7	1	5
Crack	1	140	100			40		50	23	11	1	5
	2	250	125			40		50	23	7	1	5
	3	250	100	Tube	Furn.	40	Valve	50	26	7	1	5
Gas	1	60	25			40		25	35	9	1	5
	2	60	25			40		25	35	9	1	5
	3					40		25	35	9	1	5
	4	120	125			40		25	29	9	1	5
Treat	1					40		25	35	11	1	5
Lube	1	120	50			40		40	23	11	1	5
	2	120	100			40		40	26	9	1	5
	3	120	50			40		40	26	9	1	5
	4	120	50			40		40	35	9	1	5
	5	120	50			40		40	35	9	1	5



Three of the Turbo-Mixers in Celanese's new forty-million-pounds-per-year Fortiflex® low-pressure polyethylene plant

for critical low-pressure polyethylene reactors,

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The *formative reaction* is a critical step in the manufacture of Fortiflex®—now being made in the brand-new forty-million-pounds-per-year low-pressure polyethylene plant of the Plastics Division of the Celanese Corporation of America.

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FIFTH COMPANY JOINS RACE FOR BIG SYNTHETIC "NATURAL" RUBBER MARKET

Goodyear is the latest entry into the R & D effort aimed at the sizeable market still held by natural tree-rubber in this country. Bulk of market—heavy duty truck tires, for which natural rubber has so far been the only satisfactory material.

Goodrich-Gulf has what it designates as synthetic "natural" rubber based on isoprene. Firestone has "Coral" rubber—also said to closely duplicate natural tree rubber—also based on isoprene. Esso Research and Development, in cooperation with the Pennsylvania Tire Co., has specially-produced tires made of standard commercial butyl rubber. General Tire and Rubber is still studying its recently-developed polyurethane rubber, called Genthane "S," for heavy-duty use. Now Goodyear has announced its "Natsyn" synthetic "natural" rubber, again of isoprene base.

In the laboratory, Goodyear has been producing Natsyn since about 1955, is now going into tonnage developmental production in a pilot plant at Akron, Ohio. The company claims that Natsyn has the molecular structure and performance characteristics of the natural tree-grown product.

The interest of five major companies in finding a satisfactory and economic substitute for natural rubber is based on three points:

(1) The market is huge and lucrative. In such large-scale uses of rubber as heavy-duty tires for trucks, buses, airplanes, and earth-moving equipment, where heat build-up is a major factor, only natural rubber has satisfied all requirements until recently.

(2) A world-wide shortage of tree rubber has been forecast for 1960. Tree rubber, unlike synthetic, is at the mercy of nature's somewhat slow growth and development.

(3) Interests of national defense and security dictate that the U.S. should make every attempt to be free of dependence on imported rubber, particularly when the major producing areas are susceptible to easy attack, sudden political unrest, and sudden price rises.

Many Variables

The situation is complicated by many variables such as stage of development, price, raw material supply, and performance characteristics.

Goodyear's new pilot plant, built at a cost of some $750,000, has a tonnage capacity which will enable extensive trials and evaluation. The company expects to undertake at least the engineering of a full-scale Natsyn plant soon, annual capacity would be 25,000 to 30,000 tons.

Firestone's Coral rubber has been in small pilot plant production for some time, many test tires have been produced and tested under operating conditions. Now the company is ready to open a pilot plant large enough to be designated a semi-works plant. This plant will be 20 times larger than the previous pilot plant, will produce in close to commercial quantities for extensive testing by taxicab fleets and trucks.

Goodrich-Gulf, the third producer of a so-called "natural" rubber, is in pilot plant stage, will be ready to distribute "small laboratory samples" soon, has no date in mind for going commercial.

Esso's butyl rubber for heavy duty tires and General Tire's polyurethane are not, strictly speaking, synthetic "natural" rubbers, but they are out for the same market.

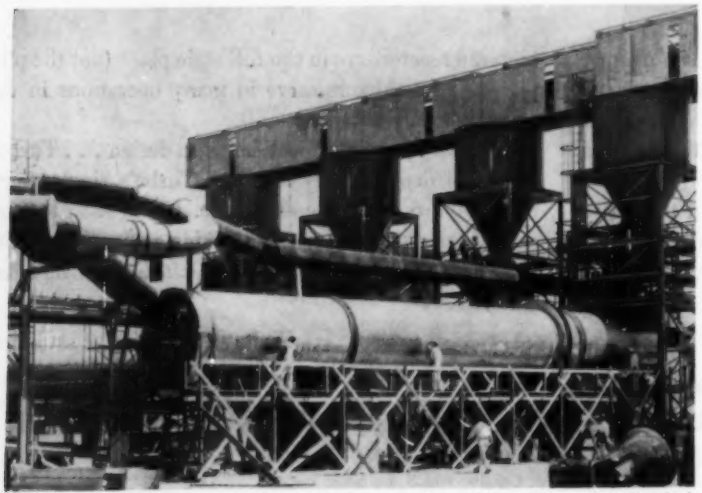
Esso's butyl tires have been approved for heavy duty truck use by the Army, have been made in sizes up to 9.00 by 20, larger sizes are in the works. Key here is a new butyl

(*Continued on page* 110)

FUELS FOR MISSILES AND JETS—EVERYBODY IN THE ACT

Three major chemical company—missile company partnerships (Stauffer-Aerojet, Callery-Thiokol, Phillips-North American), booming borax production, and a new process for boron trichloride, all point to one fact—the jet-rocket fuel field has started to attract more firms.

From the expanding production of borax to a said-to-be-cheaper process for boron trichloride developed by a small New York pharmaceutical company, the last month has been lively with jet-missile fuel production news. Reason: rising level of defense expenditures for missiles and missile research and the consequent improvement in market potential is bringing a broader range of companies into the picture.



These rotary calciners, one stainless steel clad, are part of U.S. Borax and Chemical Corp.'s new $20 million refinery at Boron, Calif.

Latest news is the Stauffer Chemical-Aerojet General partnership to develop and produce high-energy boron fuels. The company will be known as Stauffer-Aerojet, will operate principally at Azusa, Cal. To the new company, Aerojet brings long experience with boron fuels, (gained in producing more than 500,000 rockets) and the know-how involved in the production of components and full-scale propulsion units for such projects as the ICBM Titan and earth satellite Vanguard. Stauffer brings its leadership in the production of boron chemicals. Only last year, Stauffer completed the country's first large-scale plant to manufacture boron trichloride, an important chemical intermediate for fuels.

Boron trichloride brings the small Bellvue Laboratories, Inc., of New York, into the picture. Bellvue has developed a process for producing boron trichloride. The company claims its process is new, cheaper than processes now in use, has proved it

(*Continued on page* 112)

A simplified guide to select...

pumps for nuclear fluids!

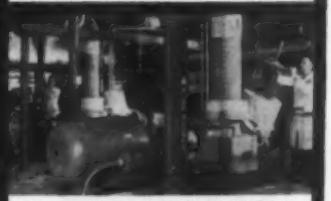
The chart below offers an easy guide to proven pump types now available for nuclear fluid handling. These pumps are listed by types of fluid circulated in the three basic commercial reactor developments.

BJ Liner Motor Pump

	FLUID CIRCULATED	RECOMMENDED PUMPS AVAILABLE	PERFORMANCE RANGES
1	PRESSURIZED WATER, BOILING WATER AND HEAVY WATER	a. Liner Motor Pumps	Capacities: To 17,000 gpm Pressures: To 5300 psi Temperatures: To 700° F.
		b. Mechanically-Sealed Pumps	Capacities: To 125,000 gpm Pressures: To 2,000 psi Temperatures: To 600° F.
2	LIQUID METALS (SODIUM, BISMUTH, ETC.)	a. Vertical-Inert Gas (Mechanically-Sealed)	Capacities: To 25,000 gpm *Pressures: Temperatures: To 1600° F.
		b. Vertical-Oil Filled Motor Pump (Mechanically-Sealed)	Capacities: To 5,000 gpm *Pressures: Temperatures: To 1600° F.
		c. Vertical-Gas Filled Motor Pump	Capacities: To 5,000 gpm *Pressures: Temperatures: To 1600° F.
	*Pressures as required	d. Liner Motor Pumps	Capacities: To 5,000 gpm *Pressures: Temperatures: To 1600° F.
3	ORGANIC	a. Special Process Pumps (Mechanically-Sealed)	Capacities, pressures and temperatures as required.
4	EXPERIMENTAL NUCLEAR DEVELOPMENTS	Byron Jackson's Nuclear Pump Section is ready to assist you in new development projects. All of the above pump types are available and new designs can be created for experimentation.	Capacities, pressures and temperatures as required.

World's largest Liquid Sodium Pump

ONLY BYRON JACKSON designs and manufactures nuclear pumps and mechanical shaft seals to answer all nuclear fluid handling requirements. BJ Pumps are in use or on order for almost all major commercial reactor developments in the United States. This broad background in nuclear pumping methods can help you find the best answer to your small or large nuclear pumping requirements... with important savings in time and money.



BJ Special Process Pump for Organic Fluids

BJ
SINCE 1872

BYRON JACKSON PUMPS
INCORPORATED
A Subsidiary of Borg-Warner Corporation
BOX 2017A, TERMINAL ANNEX • LOS ANGELES 54, CALIFORNIA

¼ HP, 2000 PSI Liner Motor Pump

This is an...

Imperwite

RUPTURE DISK

Accurate to ±5% of Rated Burst... Burst characteristics independent of temperature changes... Studies to date indicate No Fatigue Failure... Can be used at 75% of Rated Burst... Operational Temperatures to 650°F. permitted... Unaffected by action of practically all corrosives, except a few strong oxidizing agents.

RUPTURED DISK

HIGH TEMPERATURE DISK

VACUUM DISK

• IMPERVITE impervious graphite Rupture Disks are a new idea in frangibles. In addition to their other advantages, they provide almost 100% breakout of pressure membrane to allow full vent opening for safe escape of excess pressure... And because IMPERVITE Rupture Disks can be used at 75% of rated burst, they reduce the required differential between pressure vessel design and rupture disk burst pressure. Also, IMPERVITE Rupture Disks permit a smaller and less expensive inventory.

IMPERVITE Rupture Disks are available for use with gas or liquid. They are furnished in diameters from 2" to 24" for pressures from full vacuum to 250 psi at temperatures to 650°F., with a tolerance of ±5% of rated burst.

SEE US AT THE SHOW—BOOTH 131

Get full information now, for simpler, more dependable, lower cost protection of your pressured systems. Ask for Catalog No. 315.

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RUBBER MARKET

(*Continued from page* 108)

latex dip method of bonding the rubber to the tire cord. Esso is still at work testing and evaluating the use of butyl in natural rubber applications.

Genthane "S" is still in the earlier stages of development. The R & D program on this polyurethane rubber is continuing, heavy-duty tire use is very much in the market picture.

Extensive Testing, Raw Materials

In all the R & D efforts to find the best replacement for natural rubber, extensive field testing is a necessity. Passenger car tires were long since taken over by synthetic rubber, and yet for heavy duty use no synthetic has proven a match for the natural product. Any suggested replacement for tree rubber is going to have to prove itself under actual use conditions —rigorous, extensive, and extended testing. This means a great deal of time, and a considerable quantity of the experimental rubbers.

Isoprene is the key raw material in most of these rubbers. It is used to a small extent in butyl, is the main ingredient in the three synthetic "natural" rubbers. And isoprene presents a peculiar supply problem. While it can be produced by any refinery, it is not widely produced on a commercial scale now. Economically, it does not pay a refinery to produce isoprene at present, and, with the exception of the need for a sudden "crash program" based on national need, large-scale isoprene production will undoubtedly have to wait for the development of a big market. In short, while supply of isoprene is inadequate at present, there are many producers who could go ahead when and if one or all of the synthetic "natural" rubbers proves an economic replacement for natural rubber.

Price and Future

Price *vs.* performance is the main issue. So far, synthetics cheaper than tree rubber cannot do the job as well, and the experimental rubbers which have the potential to do the job as well as tree rubber are more expensive than tree rubber.

Butyl has a definite price advantage. It is cheaper than tree rubber, is not an experimental product except in the heavy duty tire application, and is in established supply. But the question with butyl seems to be just how far

(*Continued on page* 112)

CLOSING THE CONTROL LOOP AUTOMATICALLY

...with an RW-300 DIGITAL CONTROL COMPUTER

INCREASED PROFITS FROM EXISTING PLANTS

For the first time, a digital computer is available to close the control loop automatically—to provide greater profits by increasing plant throughput, improving product quality, and decreasing operating costs. The new RW-300 Digital Control Computer is engineered specifically to solve the difficult control problems of chemical plants, oil refineries, and other process industries.

The desk-size RW-300, with built-in input and output equipment, is designed to be connected directly to process instruments and controllers. It continuously monitors the instruments, makes the required computations and decisions, and adjusts the set-points of the process controllers. In addition, it prints records of operating data. RW-300 computer control is fast, accurate, and dependable.

The computer's program of instructions, stored in a magnetic drum memory, can easily be completely revised without modifying the equipment. As a result, the RW-300 can also readily handle changing control problems such as those encountered in pilot plants and research centers. The RW-300 can in addition serve as a versatile computing data logger and as a general-purpose computer.

Ramo-Wooldridge has a staff of experienced systems engineers to handle applications of the RW-300. If your company has a problem in process control, pilot plant operation, or advanced data logging, write to: Director of Marketing, Dept. CEP-802, The Ramo-Wooldridge Corporation, 5730 Arbor Vitae Street, Los Angeles 45, California.

The Ramo-Wooldridge Corporation

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for heavy duty
CORROSION PROTECTION

PHENOLINE 305

- 85% solids content
- Needs only 2 coats (12 mils)
- Gives 2-3 times longer life, eliminates 1-2 recoating cycles
- Costs less to apply
- Can be brushed or sprayed

Phenoline 305 forms a tough, non-porous maintenance coating that protects against the corrosive effects of most acids, alkalies and solvents. It gives effective, economical protection to equipment exteriors, structural steel, concrete floors and walls, and pump bases. Also used as a deck coating.

Here's rugged, heavy-duty, long-lasting maintenance protection against severe corrosive conditions. And because fewer coats give greater thickness, Phenoline 305 actually costs less than many so-called "cheaper" protective coatings. Use CARBOLINE's ENGINEERING APPROACH — compare cost per sq. ft. per year of service.

Write today for Bulletin 600 with complete information on this superior heavy-duty corrosion protection — Phenoline 305.

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32-C Hanley Industrial Ct.
St. Louis 17, Mo.

Manufacturers of
PHENOLINE, POLYCLAD, RUSTBOND PRIMERS

PHENOLINE 305

RUBBER MARKET

(*Continued from page* 110)

can it go in replacing natural rubber?

With the three synthetic "natural" rubbers, while all price, performance, process, and quantity details are still under wraps, it is obvious that the R & D efforts are based on two points:

1) Eventual price reduction below the price of tree rubber.

2) More or less exact duplication of tree rubber will produce a synthetic rubber which can do everything now done with tree rubber, force out all other substitutes and tree rubber itself.

These are not short-range programs. A great deal of time and money is involved in the work, results will probably be slow in coming. Natural tree rubber is a completely satisfactory product for heavy duty use, and any replacement will have to do a more than adequate job at a price below that of natural rubber—sudden needs of national survival discounted.

MISSILE FUELS

(*Continued from page* 108)

out in pilot plant, and now has a semi-works plant operating. Crux of Bellvue's process, according to the company, is its use of "cheap" raw materials—i.e. borax and hydrogen chloride or chlorine. About all the company will reveal at the moment is that the process is a fluid bed application, is continuous. To date, Bellvue claims three major companies in the field are interested in the process, but Stauffer is not one of them. Because the market is so lucrative, Bellvue would like to produce the boron trichloride itself, sell it to the fuel producers, rather than sell or license its process.

Callery-Thiokol and Solids

A previous major joint venture to be announced is that of Callery Chemical Co. and Thiokol Chemical Corp. Here the product to result is more definite. It will be solid boron propulsion units. Callery will make the fuel, Thiokol will build the engines.

"Solid propellants *may* be based on one of our new products, decaborane," says Callery. Decaborane and other products of the same type will be turned out by Callery in separate facilities now under construction at Lawrence, Kansas.

Desirable chemical properties and

(*Continued on page* 166)

ALLIS-CHALMERS

Water Conditioning

Announcing New Industrial Zeolite Water Softener

Basic standard water softener designs easily adapted to meet individual plant requirements.

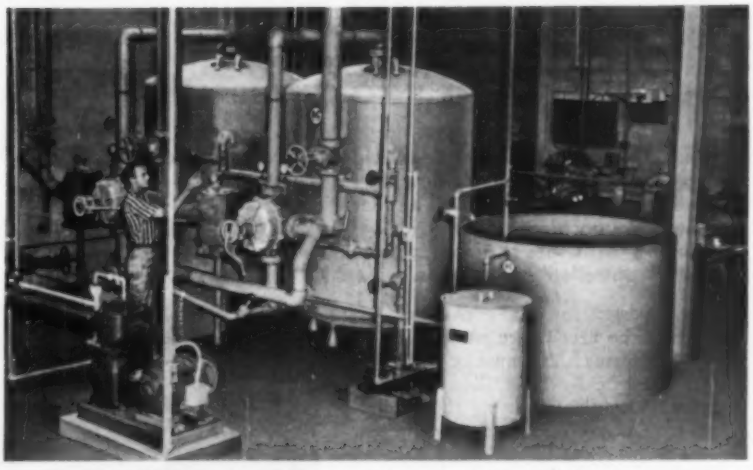
Here's a well-engineered, well-built answer to a wide range of water conditioning problems. It's designed to eliminate costly maintenance due to scaling of pipes and heat exchange tubes; to produce chemically suitable water for drying, paper making, textiles; and to provide water for food processing and many special industrial applications.

Easy Operation

The unit is basically simple. It is engineered to operate with little or no maintenance between regenerating cycles. Regeneration is an easy procedure. Automatic controls are also available to further simplify the operation if desired.

Standard Basic Design

Allis-Chalmers engineers started with a basic standard design developed from years of research and experience.



Allis-Chalmers sodium zeolite water softener installed in Ohio dye plant.

From this, a water softener is engineered to meet your individual plant requirements. Such factors as size of softener tank, size of salt and brine tank can be varied to meet your conditions.

Get Details

For complete details about Allis-Chalmers industrial type zeolite water softeners, call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS A-C ALLIS-CHALMERS

A-5552

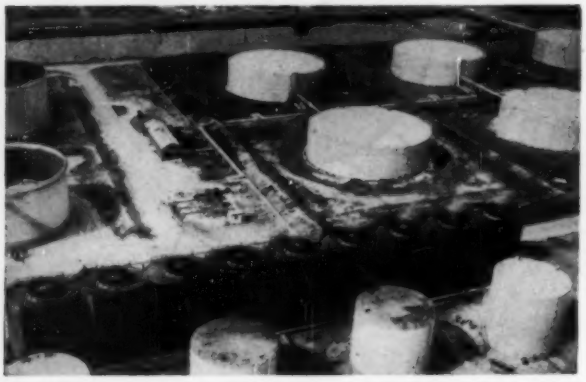
FLUOR, SUN OIL, TEAM TO OFFER INDUSTRY INDUSTRIAL WASTE WATER TREATMENT TECHNIQUE

Fluor Corporation has made an agreement to provide consulting engineering and related design and construction services to industry for Sun Oil's recently developed method of industrial waste water management.

Heart of the Sun Oil waste water treatment process, which Fluor is offering to industry, is a newly-developed technique of biological oxidation in cooling tower systems. In successful plant-scale operation for three years at Sun's Toledo, Ohio, refinery, the Sun process has attracted considerable interest as a good possibility for the economical solution of the growing problems of pollution and industrial water.

Essentially, the Sun process consists of selective segregation of waste waters at their source, reduction of specific unwanted components, collection and storage of process and area

(*Continued on page* 116)



Row of redwood cooling towers at Sun Oil's Toledo, Ohio, refinery, where biological treatment and reuse of waste water for cooling are provided simultaneously.

SYNTHETIC H_2S PLANT, MAJOR REORGANIZATION, SPOTLIGHT GIRDLER

Plans for the largest synthetic hydrogen sulfide plant ever built will be the first new job of the Girdler Construction Division of National Cylinder Gas Company. Girdler Construction Division itself has just come into existence, is one of the results of a sweeping reorganization of National Cylinder Gas and its Girdler Company Division.

To be a major unit in the $119 million nickel-cobalt project under construction in Cuba and Louisiana by Cuban American Nickel Co., a subsidiary of Freeport Sulphur Co., a new hydrogen sulfide plant will produce 60 tons/day of liquid hydrogen sulfide to process nickel sulfide from the Moa Bay ore reduction plant.

Limonite ore will be mined in Cuba, processed into nickel-cobalt sulfide at Moa Bay, and shipped to the Port Nickel, La., refinery where the new hydrogen sulfide plant will be built as part of the unusual—and much publicized—process of Cuban American Nickel. The plant will use Girdler's

(*Continued on page* 118)

GIANT LINEAR POLYETHYLENE PLANT, MAJOR POLYOLEFIN RESEARCH CENTER, PUT GRACE DEEPER INTO CHEMICALS

What may be the largest single linear polyethylene unit now in operation, W. R. Grace's new $18 million, 50 million pound a year Baton Rouge plant, is only the beginning of Grace's plans for the new "controlled" polyolefins.

As reported in *CEP's* SCOPE last month, the new Grace plant at Baton Rouge jumps U.S. capacity for linear polyethylene by 50 million pounds a year. The plant is using the Phillips Petroleum process, features many new engineering details including a maximum use of aluminum piping and equipment, was built by Fluor Corp.

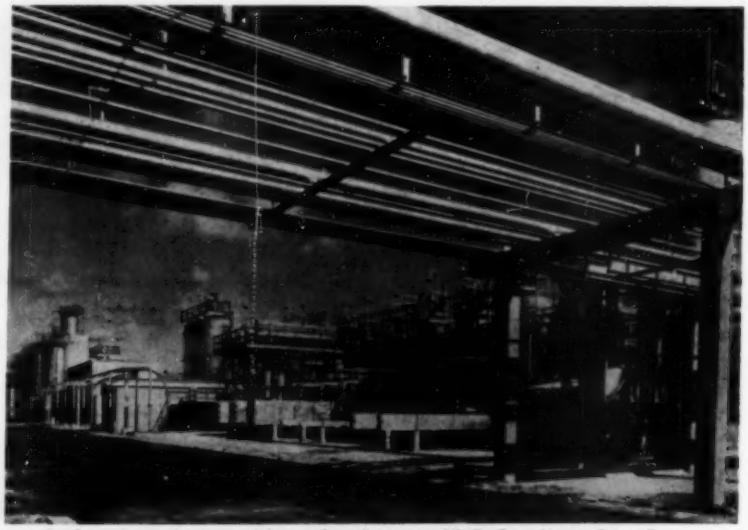
Grace is not stopping with one major plant for the new polyolefins. The company's $5 million Washington Research Center has one main building completed, a second well on its way. One of the prime concerns of the new laboratories will be polyolefin research. The company's Polymer Chemicals Division has been concentrating for some time on research leading to modified polyolefins such as copolymers using the Phillips technique. With the new Washington Research Laboratories, and the use of the million dollar semi-works plant at Baton Rouge, Grace expects eventual commercial production of new "controlled" polyolefins.

The company's semi-works plant has already served to produce the design data needed for the Baton Rouge plant, as well as serving as training ground for the operators of the plant. Plans call for the semi-works unit to provide the same services for newer polyolefins.

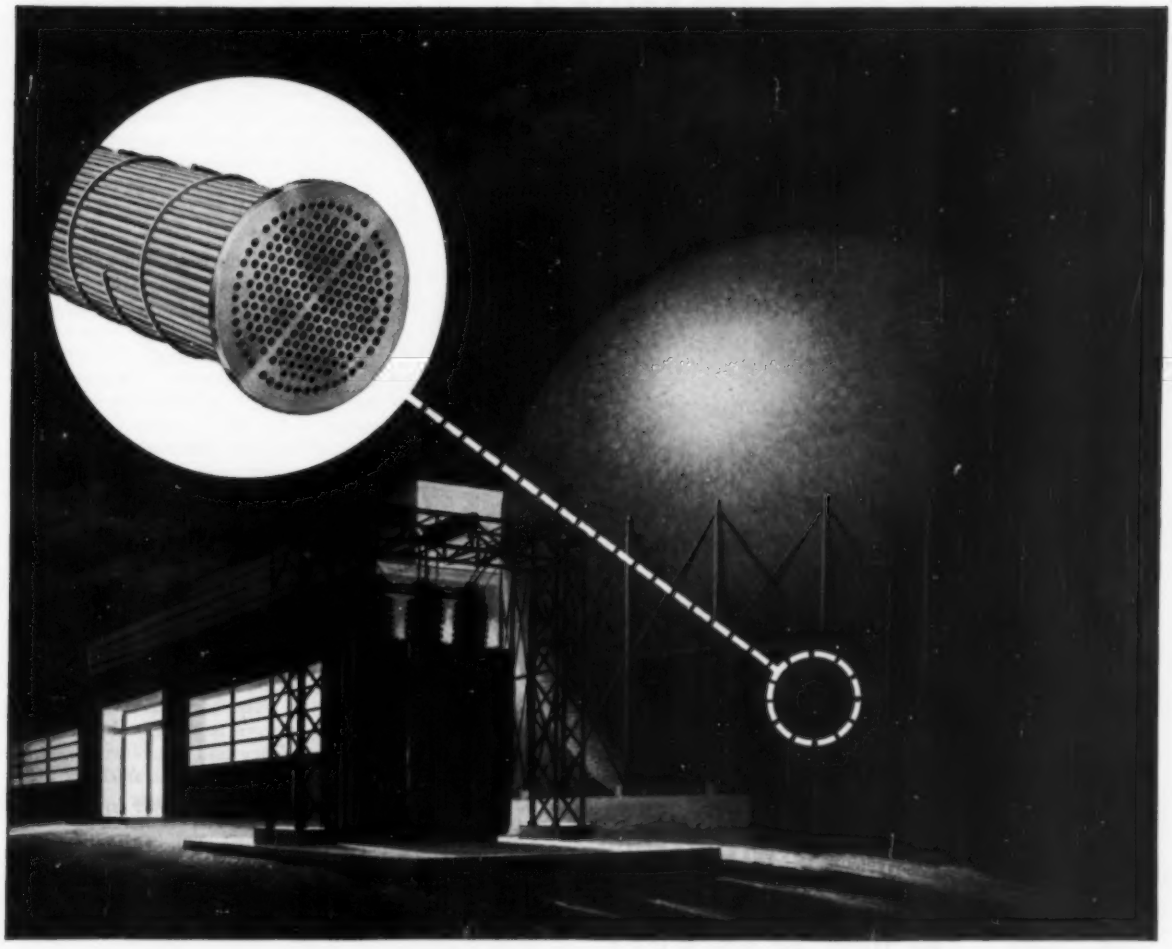
Novel Methods at Baton Rouge

An unusual and resourceful procedure was carried out by Grace to meet sales commitments. Due to equipment delays at the new ethylene plant

(*Continued on page* 120)



Emphasis is on aluminum piping and equipment at W. R. Grace's new Baton Rouge polyethylene plant.



Nuclear reactor heat exchanger tubing must not fail

That's why Superior tubing is specified

When the count starts rising in a nuclear pile and the reactor goes critical, the heat exchanger begins its vital function. Reactor heat exchangers require tubing of the highest quality.

This tubing must offer rapid and efficient heat transfer. It must be bright and clean, with extremely smooth ID and OD surfaces for uninterrupted fluid flow. Walls must be uniform throughout—no heavy sections to slow down heat transfer, no thin spots where scaling or corrosion might gain a foothold. Ductility is also important for fabrication ease. Excellent weldability is a prime requirement.

Superior has been supplying high quality tubing in a wide variety of analyses and sizes to heat exchanger manufacturers for many years. We produce to the most exacting tolerances and specifications. Get more information and free literature today on Superior tubing for atomic power. Write Superior Tube Company, 2011 Germantown Ave., Norristown, Pa.

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The big name in small tubing

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All analyses .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

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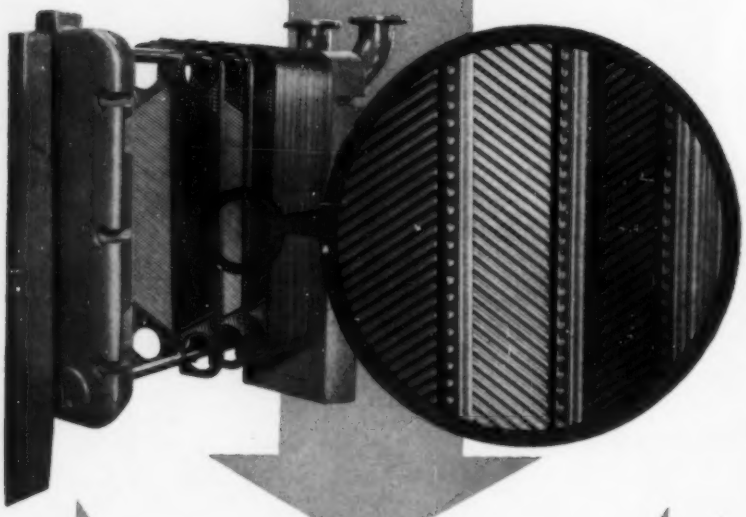
A PLATE EXCHANGER FOR HIGHER PRESSURES



THIS PLATE HEAT EXCHANGER WITHSTANDS OPERATING PRESSURES AS HIGH AS 175 P.S.I.!

THE REASONS WHY ARE:

1. The rugged internal structure of the plates, due to the herring-bone-patterned corrugations. (Plates are fabricated by an exclusive weldless pressing process that gives them great strength and uniformity and eliminates "thin spots.")
2. Fully contained gaskets that will not blow out under surge pressures as great as 300 p.s.i.
3. A sturdy frame with six or more compression bolts to provide uniform loading.

An exceptionally high heat transfer rate, even for a plate-type exchanger, is obtained in this unit from the unique flow pattern created by the V-corrugations in the plates. This exchanger gives greater flexibility, too, as the plates are quickly detachable for changing the heat transfer area.

For information about American Heat exchangers—Plate-Type or Spiral—contact your local representative, or write to: American Heat Reclaiming Corporation, 1270 Sixth Avenue, New York 20, New York.

AMERICAN HEAT RECLAIMING CORP.

REPRESENTATIVES IN PRINCIPAL CITIES

WASTE WATER TREATMENT

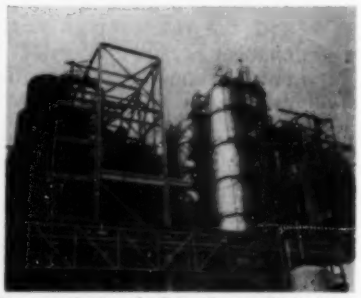
(*Continued from page* 114)

drainage, followed by reuse in conventional cooling tower systems where biological oxidation of the waste water is accomplished.

Cheap, Efficient

Re-use of industrial effluent waters is one of the most important methods leading to water conservation and pollution control—areas of operation growing steadily more important. Usually, considerable intermediate treatment has been necessary to allow re-use of the effluent water.

Now Sun and Fluor claim that the new Sun techniques, by adapting cooling towers for bio-oxidation, will eliminate the need for much intermediate treatment, including trickling filter or activated sludge equipment. Sun says that its process has resulted in water conservation savings of up to 50 per cent of plant requirements at its Toledo refinery. Equally effective, according to Sun, has been the pollution reduction. The bacterial oxidation in cooling towers at Toledo has shown high efficiency and reliability, exceeding, Sun claims, that in much conventional biological waste treatment equipment. Phenol contamination at Toledo has been reduced from 500 lb./day to 0.5 lb./day. Oil content of the final effluent has been lowered to less than one b/d, sulfides and mercaptans have been virtually eliminated, and the biochemical oxygen demand has been substantially reduced. In addition, Sun has been enabled to reduce the over-all quantity of effluent water leaving the Toledo plant as a result of re-use and evaporation in the cooling towers.



New production facilities for synthetic latex have been completed at Akron by Goodyear Tire & Rubber, will boost plant's capacity to 27,500 tons/year. Cost: $2,750,000. Main feature of expansion is addition of 10 reactors, each with a capacity of 3,750 gallons. A new recovery area (see photo above) consisting of two butadiene and two styrene recovery columns was also constructed to handle increased production.

ANNOUNCING

CROLL-REYNOLDS'

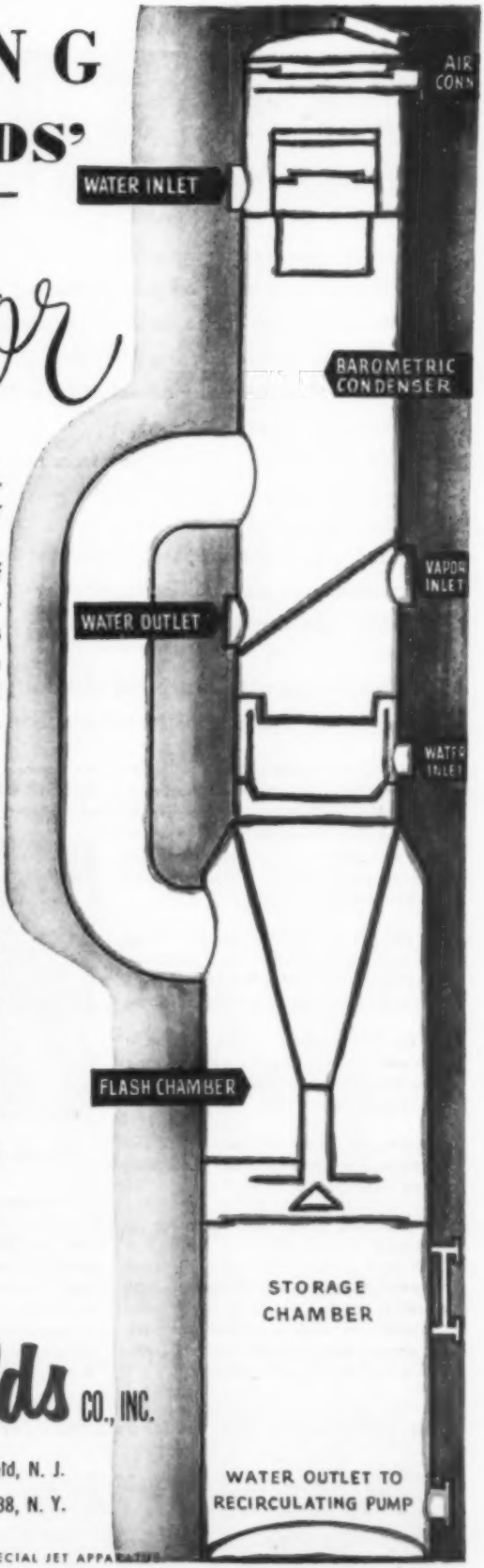
NEW Convactor

If you never heard of a CONVACTOR, do not be surprised. It is an entirely new design of special condensing tower which offers important advantages in some processes.

In the refining of edible oils it recovers fatty acids, most of which were formerly waste. It offers the additional advantage of totally eliminating stream pollution from this source or the expense of cleaning cooling towers which collect such deposits. It has similar application in fatty acid stills, some other types of distillation processes, dryers, and other large vacuum processing units.

The CONVACTOR is a combination of two condensers and a vacuum cooling chamber. One condenser is of conventional barometric design, the other a highly improved condenser working on the jet principle. The latter condenses the vapor from the process and discharges directly into the vacuum cooling compartment where the heat of condensation is immediately removed. The cold water is then recirculated through the same jet condenser. The flashed vapor from the cooling operation is condensed in a conventional barometric condenser using water from a river, cooling tower or other industrial source. Periodic blow-down or continuous bleed-off from the flash chamber permits recovery. Several large industrial installations have been made.

It is significant that this new contribution to vacuum equipment should come the year we are celebrating our Fortieth Anniversary.



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CHILL-VACTORS • STEAM-JET EVACTORS • AQUA-VACTORS • FUME SCRUBBERS • SPECIAL JET APPARATUS

DRY AIR . . .
PRECISELY as you want it

- to control your product's quality
- to prevent condensation on your product or material
- to prevent changes due to moist air in contact with your product
- to protect your material from dampness
- to protect your processing of moisture-sensitive material
- to DRY your material or product
- to pack or store your product safe from moisture damage
- to get exact moisture control for the precise atmosphere condition you need
- to provide precise atmospheric conditions for testing
- to increase your air conditioning capacity
- to DRY large quantities of fresh air from outdoors

The Niagara's Controlled Humidity Method using HYGROL moisture-absorbent liquid is

Best and most effective because . . . it removes moisture as a separate function from cooling or heating and so gives a precise result constantly and always. Niagara machines using liquid contact means of drying air have given over 20 years of service.

Most reliable because . . . the absorbent is continuously reconcentrated automatically. No moisture-sensitive instruments are required to control your conditions.

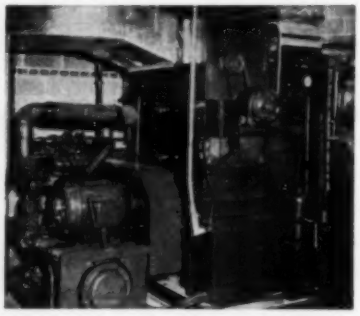
Most flexible because . . . you can obtain any condition at will and hold it as long as you wish in either continuous production, testing or storage.

Easiest to take care of because . . . the apparatus is simple, parts are accessible, controls are trustworthy.

Most compact, taking less space for installation.

Inexpensive to operate because . . . no re-heat is needed to obtain the relative humidity you wish in normal temperature ranges and frequently no refrigeration is used to remove moisture.

The cleanest because . . . no solids, salts or solutions of solids are used and there are no corrosive or reactive substances.



Niagara Controlled Humidity Air Conditioning

This method removes moisture from air by contact with a liquid in a small spray chamber. The liquid spray contact temperature and the absorbent concentration, factors that are easily and positively controlled, determine exactly the amount of moisture remaining in the leaving air. Heating or cooling is done as a separate function.

Write for full information; ask for Bulletins 112 and 121. Address Dept. EP-2

NIAGARA BLOWER COMPANY
405 Lexington Ave., New York 17, N. Y.
District Engineers in Principal Cities of U. S. and Canada

SYNTHETIC H_2S PLANT

(*Continued from page* 114)

process, which is based on the reaction of hydrogen with liquid sulfur at elevated temperatures and pressure. Actual pressure will be above 125 lbs./sq.in. gauge. The hydrogen is supplied at 150 lbs./sq.in. gauge or higher, molten sulfur at 250° to 300° F. is pumped into the equipment from a sulfur melting pit. The reaction forming the hydrogen sulfide takes place at 800° to 900° F. The temperature is maintained by the exothermic heat of reaction which may be augmented by a heater submerged in the liquid sulfur. Fresh sulfur is continually introduced to maintain the proper reactor level.

Major Reorganization

Main changes in National Cylinder Gas' organization are the consolidation of most chemical operations into a new Chemical Products Division, and the splitting of the former Girdler Company Division into three divisions: a primary part of the Chemical Products Division, the Girdler Construction Division, and the Girdler Process Equipment Division.

The Chemical Products Division will manufacture specialty catalysts, organic pigments, flushed colors, pharmaceutical intermediates, and other chemicals. Walter H. Girdler, Jr., former vice-president of the original Girdler Corporation and vice-president of National Cylinder Gas, will be president of the Chemical Products Division.

Girdler Construction Division, the builder-to-be of the new hydrogen sulfide plant, was formerly the Gas Processes department of Girdler Company. It will engineer, design, and construct process plants and equipment for the chemical, petroleum, and other industries. Heading this division will be W. R. Wood, former head of the Girdler Company Division.

Girdler Process Equipment Division will produce Votator heat exchange equipment. The NCG Division will produce the company's industrial gases.

A continuous process for production of acetylene and ethylene from naphtha or natural gas feedstocks is offered by M. W. Kellogg Co. Heart of the process is said to be a burner developed by Societé Belge de l'Azote of Belgium, originators of the process. □

BUTADIENE CAPACITY INCREASED
365,000 Tons/yr in 1957
85% THRU ISOFLOW HEATERS

... and "Isoflows" in five new Butadiene plants are additionally supplying 1,000,000 lbs/hr of superheated steam up to 1400° F

Butadiene capacity is mushrooming to meet the rising demands of synthetic rubber and chemicals. Of the new butadiene plants put into operation during 1957, Petrochem Isoflow Furnaces have been installed in the 5 largest, representing approximately 85% of the total increased capacity in the U.S.

Isoflow Furnaces efficiently perform two important heating functions, depending upon the butadiene process involved:
(A) To heat directly the butane-butene feed stock and steam to a high temperature for dehydrogenation.
(B) To supply highly superheated steam which in turn heats the butane-butene stock for dehydrogenation.

The unique design and operating features which have led to the wide acceptance of Petrochem Isoflow Furnaces include:

- **Uniform Heat Distribution**
- **Maximum Fuel Efficiency**
- **Low Pressure Drop**
- **Low Maintenance**
- **Zero Air Leakage**
- **Minimum Ground Space**
- **Simplicity of Design and Construction**
- **Short Length of Liquid Travel**
- **Series, Multipass, all parallel flow**
- **Excess Draft for High Overload**

For butadiene production, catalytic reforming or any other petroleum, petrochemical or chemical process there's a Petrochem Isoflow Furnace for any duty, temperature and efficiency.

PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

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FOR NON-LUBRICATING AND CORROSIVE FLUIDS

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and Eco is the only manufacturer who has made it available. The first self-priming rotary gear pump suitable for non-lubricating and corrosive fluids is now available for immediate delivery. The pump, with ¾" P.T. inlet and outlet ports, features housings of 316 or Carpenter 20 stainless steel, Hastelloy C or nickel, with reinforced Teflon gears and internal Teflon bearings and packing.

Designated the GearChem*, this pump is suitable for speeds to 1750 rpm at capacities to 10 gpm and pressures to 100 psi. Viscous media to 5000 SSU can be pumped at reduced speeds.

The GearChem created tremendous interest at the recent Chemical Show. In addition to proportioning and metering applications the pump is ideal for general process work in pilot plant and production operations.

Write for prices and complete information.

* T.M. Applied For

Teflon—duPont trademark

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the big name in small pumps

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GRACE POLYETHYLENE

(*Continued from page* 114)

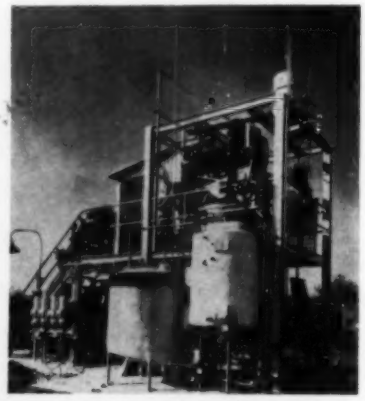
under construction four miles away by Grace's future ethylene supplier, a unique supply plan had to be improvised for the interim period. A fleet of high-pressure gas truck trailers was assembled to bring ethylene from East Texas and accumulate it in underground ethylene storage facilities.

Aluminum construction was used in the plant wherever possible, both for economy and for freedom from product contamination. Of special note are two large horizontal steam tube dryers, 55 ft. long and 5 ft. in diameter, said to be the first all-welded aluminum dryers ever built—maker, Standard Steel Corp. of Los Angeles. Piping is largely of aluminum, all insulation is encased with corrugated aluminum.

Canalization

Under study for several years, final bids have now been submitted on a barge canal to connect the Baton Rouge area with the Mississippi river; the new canal will border the site of the new Grace plant.

Medium-density polyethylene production has been started by Eastman Chemical in Longview, Texas. Compared to conventional low-density polyethylene, the medium-density material has greater stiffness, higher heat resistance, and greater abrasion resistance in molded products. Eastman also announced a planned overall 50% increase of polyethylene production to 85 million pounds by the end of 1958. □



A new Grignard reaction production unit, designed to double carbinol production at van Ameringen-Haebler's Union Beach, N. J., synthetic aromatic chemicals plant, has just been completed. The unit, part of a $1,500,000 expansion program, features improved process control through the use of automatic equipment.

SULPHUR

helps to create headline products

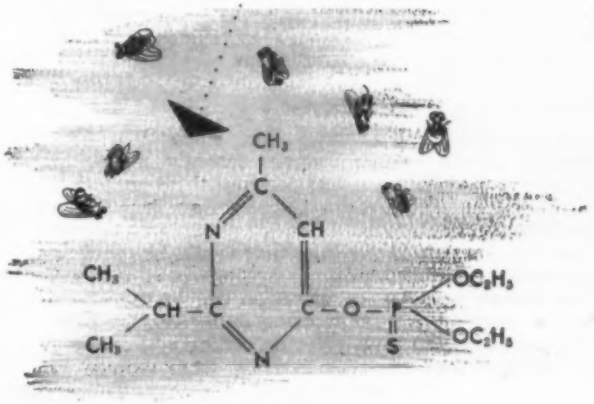
DIAZINON*

What a 'killer' this complex chemical is turning out to be! And quite impartial as to its victims: — houseflies, barnflies, fruitflies, aphids, mites, ants, beetles, chinch bugs, roaches, and many other pests that bother man and beast. It kills them dead!

As with the former chemicals which made such notable headway in man's fight to subdue these destructive pests, Sulphur is very much in the picture—here is one of the many variations of the benzene ring . . . the Diazinon Formula. That letter "S" tied in with the letter "P" discloses the all-important thiophosphate.

Sulphur, often called one of the Four Pillars of the Processing Industry, is benefiting mankind in many ways. None is more important than that of controlling crop-destroying pests.

**A product of the Geigy Chemical Corporation.*



Texas Gulf Sulphur Co.

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- Spindletop, Texas
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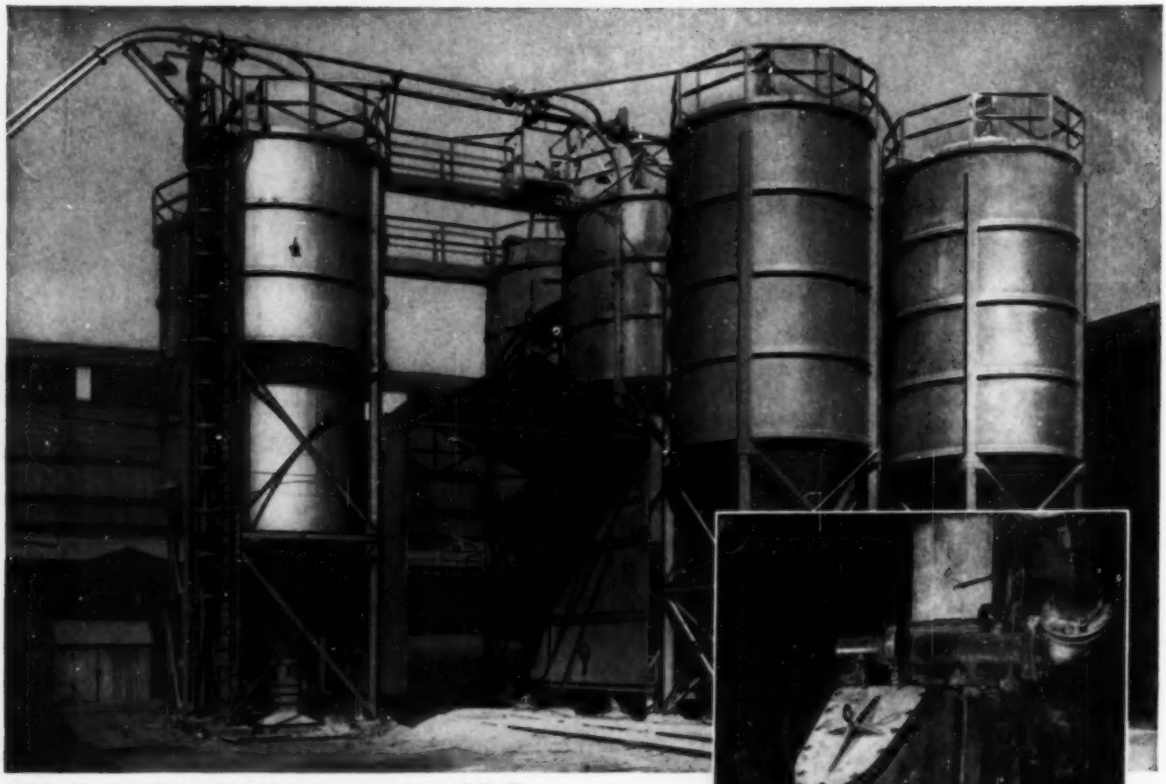

Storage bins into which sand ingredients are conveyed by a Fuller-Kinyon Conveying System. Note the pipe-line system which permits ingredients to be conveyed into their respective bins.

One of two Fuller-Kinyon Pumps which convey sand ingredients to storage bins and from bins to mixers.

FULLER-KINYON CONVEYING SYSTEM HANDLES THREE DIFFERENT MATERIALS EFFICIENTLY, WITHOUT WASTE

To reduce costs and speed up handling of foundry sand ingredients with minimum waste, General Steel Castings Corporation, Granite City, Illinois, installed a Fuller-Kinyon Conveying System.

Here's what it does for them—

The system unloads corn flour, silica flour and bentonite from hopper bottom cars by means of Fuller-Kinyon Pumps which convey these materials through pipe lines to a number of storage bins. The flexibility of the system makes it possible to unload cars in a fraction of the time that would be required manually, *and*, waste due to spillage is eliminated. Two pumps used in the operation can be moved on narrow gage tracks for spotting under cars or bins. One pump is used mainly for unloading and delivery to storage—the other for delivery from storage to supply bins above the mixers. However, it is possible to unload cars and reclaim from storage simultaneously. Where bins are located so that they cannot discharge directly to a pump, an F-H Airslide® conveys from bins to the pump.

Prior to the Fuller installation, material was received in bags and manually unloaded, stored and transported to the mixers. It figures—*costs were much higher.* Now, waste has been eliminated! Another important feature—the company has realized extra savings by purchasing materials in bulk.

Fuller air-conveying systems are in operation in hundreds of plants throughout industry, cutting costs and increasing profits, day in and day out. The next time you have a materials-handling problem, why not get in touch with Fuller . . . chances are you will also profit.

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P-168
4038

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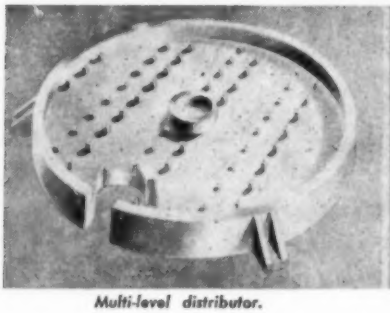
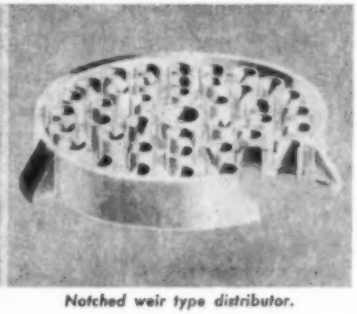
CEP Data Service

NEW LIQUID DISTRIBUTOR DESIGNS IMPROVE INITIAL DISTRIBUTION



Multi-level distributor.



Notched weir type distributor.

404 Two new distributor designs have been introduced by U.S. Stoneware to meet the present demand for improved initial liquid distribution in larger diameter packed columns. The "Multi-Level" distributor is designed for use with fractionating and drying columns, and other installations with relatively low to medium liquid rates. The device is essentially a tray with a perforated bottom; however, the arrangement is such that the perforations drain at three different levels. Uniform distribution of liquid across the entire column will start as soon as the flow of liquid covers the bottom of the tray. An increase in the rate of flow above this minimum will raise the liquid level in the tray. When the level reaches the height of the small pads in the bottom of the tray, the number of openings through which the liquid passes doubles automatically. A further increase in the rate of flow will raise the liquid level until it reaches the higher pads, increasing by half again the number of holes. Thus, the original rate of flow is trebled, still maintaining uniform liquid distribution. The "Multi-Level" distributor is made in porcelain in a range of sizes to fit towers from 24 to 60 in. diameter.

The "Weir-Flow" distributor provides uniform liquid distribution over a wide range of medium to high liquid rates. Cylindrical risers with "V" notches are used as downcomers for the liquid, permitting greater flow as the head increases. Gas passes partially through these risers and partially through an annular space between the tray and the column wall. "Weir-Flow" distributors are made in stoneware to fit towers up to 8 ft. diameter, and in metal to fit towers from 12 to 48 in. diameter, with larger sizes built to specifications.

For further technical information on these two new distributor designs, circle number 404 on Data Post Card.

MAGNESIA INSULATION INCREASES SAVINGS AND SAFETY

Double-layer insulation of process vessels and piping at large natural gasoline plant said to give improved temperature control, increased heat savings, added fire protection.

405 At a large Southwest natural gasoline plant, all process vessels and exchangers operating over 400° F. were covered with two layers of 1½ in. Thermalite 85 per cent magnesia insulation made by Ehret Magnesia Manufacturing Co. According to the company, increased savings and safety more than offset the additional installation cost.

The plant in question has a capacity of 190 million std.cu.ft. of gas per day and operates on an around-the-clock seven-day schedule producing gasoline, isobutane, kerosene, LPG, and fuel oil. Process steam is generated in three outdoor boilers and enters the plant through 10 in. lines at 522 and 305° F.

All process vessels and exchangers operating under 400° F. are covered with a 2-in. single layer of the Thermalite magnesia, and single layers of sectional Thermalite are applied to all high-temperature, small diameter pipe lines and to larger lines carrying fluids at less than 340° F. Thickest insulation used (for 500° F. or over) is 3-in., made up of two 1½ in. thick layers.

Two finish coats are used: the first of ½ in. thick insulating cement; the second

(Continued on page 134)

AT THE CHEM SHOW . . .

Seen at the Chem Show: Special 15,000 amp. germanium rectifier developed by Allis-Chalmers for service in the electrochemical industries.

Hoffman

Lynds

CEP editorial staff members add functional titles

Dennis J. Lynds, associate editor of **CEP**, has been named Business and Management Editor. Waldo B. Hoffman, also an associate editor, has been made Process and Equipment Editor. William B. Guth, likewise an associate editor, has been appointed Engineering and Profession Editor. In their new areas of specialty, Lynds will cover chemical industry developments, marketing, etc., and Hoffman will report new developments in equipment and materials of construction of significance to processing. Guth will cover professional activities and development, and will also serve as administrative aide to the Editor.

J.B.M.

GRAPHITE LARGE BLOCK HEAT EXCHANGER

406 "Delanium" graphite heat exchangers, made by Powell Duffryn Carbon products, Ltd., and sold in the United States by Delanium Graphite Co., are now available with larger heat transfer areas and larger hole (tube) diameters. The new series extends the range of these exchangers to 200 sq.ft. with a tube diameter of ¾ in.

The design of the new models is similar to Delanium's patented block type exchanger except that the graphite sub-assembly is no longer a cube, but is extended to a rectangular shape, giving a hole or a tube length of 6 feet. The new series is described in detail in an illustrated data sheet which gives dimensions, numbers of tubes, effective surface areas, pass arrangements, flow patterns, and other pertinent design data.

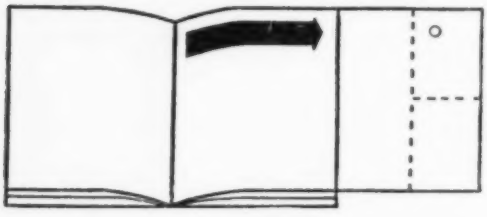
Advantages of the new design include:

- Corrosion resistance on both sides to most acids, alkalis, and solvents.
- High overall heat transfer under conditions of heating, cooling, evaporation, or condensation.
- Controlled velocities for both fluids over a wide range of flow rates.
- Compact and sturdy (no floating head, no packing, no gaskets between fluids).
- Tubes accessible for cleaning and maintenance on both sides.

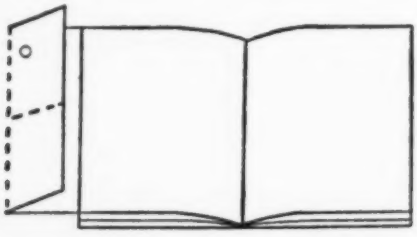
For details and design data from "Delanium" Graphite Co., circle number 406 on Data Post Card.

JUST A MOMENT is needed to learn how to use this insert. When looking through the front part of the magazine, pull the folder portion of the insert out to the right, and the numbers on the post card are convenient for circling.

THEN . . .



AS YOU PASS the pull-out page, and it is on the left, fold the post card back along the vertical scoring, and once again the numbers are handy for circling.



Numbers followed by letters are for checking your interest in the products, equipment, and services advertised in this issue, the number corresponding to the page on which the ad appears. Letters indicate position on the page: L, left; R, right; T, top; B, bottom. A indicates a full page; IFC, IBC, and OBC are cover advertisements. **Numbers in the 300-series** bring you new engineering data in the chemical engineering field.

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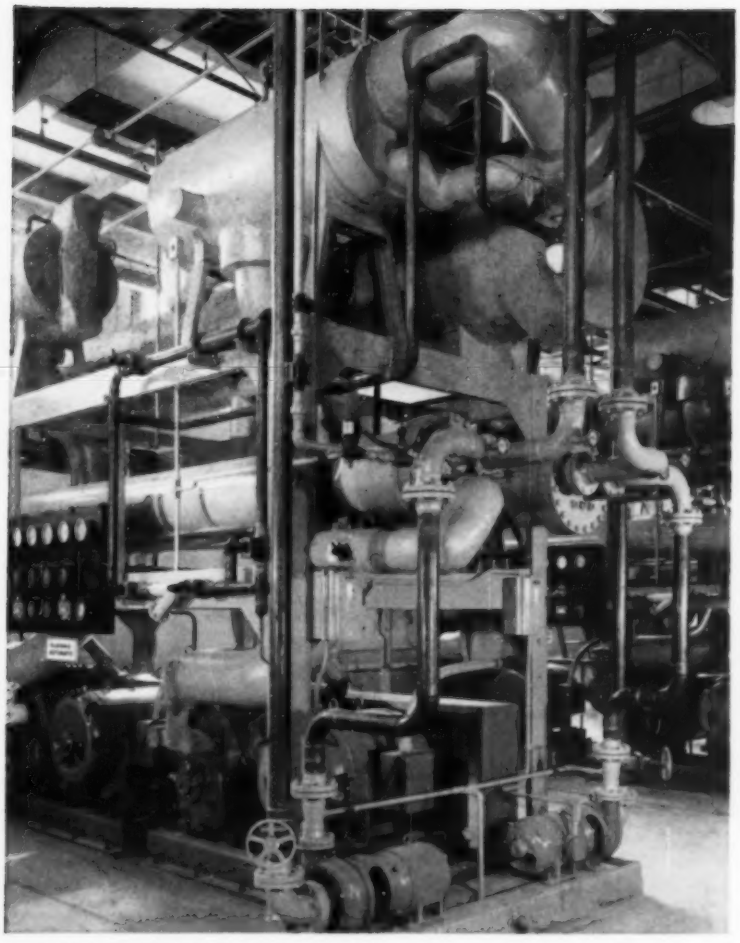
38A-39A Industrial Equipment. Booklet from Dresser Industries on their products and services.
40L Continuous In-Line Agitator. Bull. 92 from New England Tank & Tower.
41A-42A Polyethylene Piping. U. S. Industrial Chemicals.
43A Oxygen Production Equipment. Air Products Inc.
45A High Efficiency Filters. Data from Cambridge Filter Corp.
46L Steam Jet Ejectors. Graham Manufacturing Co.
47A Air Preheaters. Technical data from Air Preheater Corp.
49A Impervious Graphite Heat Exchangers. National Carbon Co.
50A Chemical Relief Valves. Milton Roy.
51A Equipment Fabrication. Bethlehem Foundry & Machine.
52A Equipment Fabrication. Booklet from Downingtown Iron Works.
54A Conveying and Dust Removal Systems. Brochure from Fluor Products Co., Hartmann Div.
56A Tower Packing. Bull. S-29 on Intalox Saddle packing. U.S. Stoneware.
107A Mixers. Bull. from Turbo-Mixer Div., General American Transportation.
109A Pumps for Nuclear Fluids. Byron Jackson Pumps.
110L Impervious Graphite Rupture Disks. Catalog 315 from Falls Industries.
111A Digital Control Computer. Data from Ramo-Wooldridge on the RW-300.
112L Protective Coating. Bull. 600 on Phenoline 305. Carboline Co.
113A Zeolite Water Softener. Data from Allis-Chalmers.
115A Heat Exchanger Tubing. Superior Tube Co.

PRODUCT INDEX

116L Plate-Type Heat Exchanger. American Heat Reclaiming Corp.
117A Condensing Tower. Data from Croll-Reynolds on its "Convactor."
118L Air Conditioning Equipment. Bulls. 112 and 121 from Niagara Blower.
119A Industrial Furnaces. Petro-Chem Development Co.
120L Teflon Gear Pump. Prices and data from Eco Engineering.
121A Sulfur. Texas Gulf Sulphur Co.
122A Pneumatic Conveying Systems. Fuller Co.
127A Heat Transfer Equipment. Patterson-Kelley Co.
129A Bulk Material Handling Equipment. Bull. 349 from Stephens-Adamson Mfg.
131A Automatic Wet Cyclone Classifiers. Data from Dorr-Oliver.
133A Molecular Stills. Bull. from Arthur F. Smith Co.
135A Evaporators. Chicago Bridge & Iron Co.
136L Rotameter Bulletin. Schutte and Koerting Co.
137A Expansion Joints. Adsco Div., Yuba Consolidated Industries.
139A Non-Lubricated Lift-Plug Valves. Cameron Iron Works.
140L Industrial Wire Cloth Catalog. Cambridge Wire Cloth Co.
141A Plant Design, Engineering, Construction. Foster Wheeler.
142L Filter Paper. Catalog 357 from Eaton-Dikeman Co.
143A Electronic Potentiometers. Bull. 20-10 from Foxboro Co.
145A Conical Dryers-Blenders. Data from Pfaudler Co.
146L Rare Earth Metals. Michigan Chemicals Corp., Rare Earths and Thorium Div.
147A Plant Design and Construction. Badger Manufacturing Co.
149A Chemical Pumps. Design booklet from Peerless Pump Div., Food Machinery and Chemical Corp.
150L Rotary Gear Pumps. Bull. G-2 from Sier-Bath Gear & Pump Co.
151A Leak-Proof Pumps. Data from Chempump Corp.
152L Crystals. Crystals, Inc.
152BR Centrifugal Pumps. Bull. "H" from Nagle Pumps, Inc.
153A Filter Research Service. Industrial Filter & Pump Mfg. Co.
155A Mixers. Booklet from Simpson Mix-Muller Div., National Engineering.
156TL G-M Counter Tubes. Data from H. W. Leighton Laboratories.
156BL High Purity Fused Quartz. Amersil Quartz Div., Engelhard Industries.
157A Stainless Steel Plate. G.O. Carlson.
158L Flexible Pipe Connectors. Crane Packing Co.
159A Process Compressors. Form 3132-A from Ingersoll-Rand.
160L Water Still Catalog. Barnstead Still & Demineralizer Co.
160BR Nuclear Flow Counting Gas Mixtures. Matheson Co.
161A Carbon Anodes. Great Lakes Carbon Corp.
162L Tank Vents and Flame Arrestors. Catalog 76-16 from Black, Sivalls & Bryson.
163A Piston-Type Fillers. Bull. PED 257 from Girdler.
164TL Metal Joints for Lab Equipment. Ace Glass, Inc.
164BL Heatless Desiccant Air Dryers. Kahn and Co.
165A Heat Exchanger Catalog. Efco Heat Transfer Equipment.
166TL Laboratory Furniture. Catalog from Metalab Equipment Co.
166BL Thermocouple Wire. Bull. 31-300-V from Thermo Electric Co.
167A Crystallizers. Bull. CE-57 from Struthers Wells.
168L Water Conditioning Equipment. Delonizer Bull. 512 from Elgin Softener Corp.
169A Heat Exchangers. Yuba Consolidated Industries.
171A Combination Piston-Diaphragm Pump. Bull. 440 from Lapp Insulator Co.
172L Continuous Weighing Systems. Technical data from Thayer Scale Corp.
173A Chemical Process Pumps. Aldrich Pump Co.
174L Plastic Piping and Valves. Technical Data CE-50 from American Hard Rubber Co.
175A Filters. Continuous vacuum and pressure designs. Eimco Corp.
176L Air Separators. Bull. 067 from Sturtevant Mill Co.
176BR Liquid Oxygen-Nitrogen Unit. Catalog from Hofman Laboratories.
177R Filter Press Catalog. D. R. Sperry & Co.
178L Flexible Couplings. Data, Lovejoy Flexible Coupling Co.
178BR Tank Content Meters. Bulls. Uehling Instrument Co.
179BL Nuclear Consulting Services. Astra, Inc.
179R Air Pollution Control Equipment. Claude B. Schneible Co.
180L Corrosion Detectors. Data sheets from Tinker and Rasor.
181L Plastic Pipe Bulletin. Kraloy Plastic Pipe Co.
181R Industrial Chemicals. Tennessee Corp.
191A Van de Graaff Accelerator. Bull. G from High Voltage Engineering.
192L Fume Washers. Bull. 90 from Maurice A. Knight.
193A Alloy Equipment Fabrication. Graver Tank & Mfg.
194L Nickel Alloy Fabrication. Misco Fabricators.
194TR Heating Coils. Bulls. 355 & 258 from Dean Products, Inc.
194BR Prospectus on Nuclear Stocks. Atomic Development Securities Co.
195R Automatic Centrifugals. Data from Fletcher Works.
198L Fused Silica Lab Ware. Bull. from Thermal American Fused Quartz Co.
198TR Pipette Fillers. For dangerous solutions. Instrumentation Assoc.
199R Silicone Coatings. Midland Industrial Finishes Co.
200L Small-Diameter Alloy Tubing. Tube Methods, Inc.
200R pH Control Handbook. W. A. Taylor & Co.
201R Removable-Header Heating Coils. Bull. R-50, Aerofin Corp.
203BL Flow Meter Bulletin. Burgess-Manning Co.
203TL Portable Small Capacity Filters. Ertel Engineering Corp.
203R Jacketed Relief Valves. Dimension sheets and prices from Parks-Cramer Co.
204L Process Equipment Fabrication. Manning & Lewis.
205BL Sub-Micron Filters. Data sheets from Flanders Filters, Inc.
205TL All-Plastic Gate Valve. Catalog FP-1 from Vanton Pump and Equipment.
205R Rotary Screener. Data and prices from J. M. Lehmann Co.
206L Liquid Processing Equipment. Alsop Engineering Corp.
207T Dry Materials Feeder. Vibra Screw.
207B Large-Diameter Alloy Pipe. Posey Iron Works.
208BL Gauge Glass and Cylinders. Swift Glass Div., Swift Lubricator Co.
209TL Steam-Jacketed Kettles. Catalog from B. H. Hubert & Son.
209BL Spray Nozzles. Catalog 24 from Spraying Systems Co.
209R Flexible Metal Hose. Bull. IND-4 from Packless Metal Hose.
212TL Radiation Detection Services. Health Physics Services Co.
212BL Peristaltic-Action Pump. Catalog from Sigmamotor, Inc.
213BL Engineering and contracting Services. C. W. Nofsinger Co.
IBC Nuclear Research Facilities. Ralph M. Parsons.
OBC Bulletins on Mixers. Mixing Equipment Co.



AUTOMATICALLY CONTROLLED supply of −40°F ammonia for process use is produced in ammonia reflux system (left). Two duplex 150 hp Worthington reciprocating compressors are used for low temperature brine system (right). All heat exchange equipment was supplied by Patterson-Kelley.

HOFFMANN-LaROCHE

calls on reliability, efficiency of

P-K EQUIPMENT

for giant cascade refrigeration system

One of the largest automatic cascade refrigeration systems ever built is now operating full-time at the Hoffmann-LaRoche plant in Nutley, New Jersey. This system with 2000-H.P. capacity provides −40°F ammonia and 10°F brine for special process work. Exchangers contain 73,590 feet of tubing. Photo shows one of 4 duplex brine units (4 duplex and 1 single low temperature unit not shown).

In addition, the system offers a unique answer to one of the most complex problems in the refrigeration industry: to provide, automatically, a continuous supply of accurately controlled low temperature ammonia. This was made possible by the use of P-K balance loaders and slug eliminators.

The system, designed by Mr. J. W. Obreiter, Jr., consulting engineer of Hoffmann-LaRoche, is made up of an ammonia reflux system and a low temperature brine system.

Next time your system demands efficient, trouble-free heat transfer performance, it will pay you to call in Patterson-Kelley. For details on the exact equipment to fit your needs, write the Patterson-Kelley Co., Inc., 1702 Burson St., East Stroudsburg, Pa.

P-K also makes a complete line of dry expansion, internal fin freon chillers. Write for P-K bulletin 106-T-1.

Patterson Kelley

Flooded and Dry Expansion Type Freon Coolers and Storage Water Coolers • Freon Condensers • Allied Refrigeration and Air Conditioning Equipment

MATERIALS

301 Silicone Molding Compounds. Brochure from Dow Corning Corp. discusses thermal conductivity, electrical properties, strength-to-weight ratio. Many charts, graphs, field examples.

302 Non-Toxic Solvent and Intermediate. Booklet from Pennsalt Chemicals Corp. describes properties and applications of ethylsulfonylethanol.

303 Booklet on Hydrogen Peroxide Dilution. Detailed, concise information on methods and equipment for diluting commercial grade hydrogen peroxide. Dilution charts, formulas, information on containers, stability tests. Solvay Process Division, Allied Chemical & Dye.

304 Fired Refractory Materials. Condensed catalog from Richard C. Remmey Son Co. presents line of fired refractory materials, technical data on cements, catalyst carriers, heat exchange pebbles, furnaces and kilns.

305 Polyvinyl Chloride Pipe Catalog. Properties, corrosion resistance, application data, installation information, contained in 30-page catalog from A. M. Byers Co.

306 Fatty Acids, Industrial Oils. Specifications and compositions of over 180 fatty acids, fatty acid derivatives, and industrial oils in new product catalog from Armour and Co., Chemical Division.

307 Booklet on Polyvinylpyrrolidone. Detailed, 48-page booklet on PVP, high-molecular weight polymer. Chemical and physical properties, applications. Antara Chemicals, General Aniline and Film Corp.

308 Methanesulfonyl Chloride. Technical bulletin from Stauffer Chemical Co. gives properties and reactions of methanesulfonyl chloride, suggested for use as intermediate in manufacture of pharmaceuticals, dyestuffs, other organic chemicals.

309 Extender for Phenolic and Furan Resins. West Virginia Pulp and Paper Co. offers technical bulletin describing Indulin, an extender for phenolic and furan resins.

310 Data on Acrylic Latex Paints. Progress report from Rohm and Haas Co. gives summaries and tables of test results on more than 3,000 test exposures in Florida, Pennsylvania, and Arizona, also results of laboratory and industrial tests.

311 Technical Bulletin on Cyclohexanol. 32-page brochure from National Aniline Division, Allied Chemical & Dye, contains 10 pages of physical and chemical properties, describes all principal reactions. Also 11 pages of suggested uses.

312 Synthetic Silica Products. New silica gels, hydro gels, other synthetic silicas introduced in new 4-page brochure from American Industrial Chemical Co., Division of Amerace Corp.

314 Molded Activated Carbon. New line of cube and wafer shapes, claimed much easier to handle than granules of equal volume. Further technical information from the manufacturer, National Carbon Co.

315 Chemical Product Index. Catalog from Celanese Corp. of America, Chemical Division, gives properties of wide range of intermediates, plasticizers, gasoline additives, functional fluids, solvents. Price and delivery information also available.

316 Asbestos Sheet Packing and Gaskets. List of 120 chemicals that can be handled safely, tables giving stock sizes of sheets in five different gauges, prices and dimensions of gaskets. Bulletin from Durabla Manufacturing Co.

317 Corrosion Data on Copper. Revised edition of "Corrosion Resistance of Copper and Alloys," 32-page reference booklet, offered by American Brass Co.

318 Saran Products. Bulletin with technical data, shapes, sizes, prices on Saran rod, sheet, tape, pipe, tubing, and fittings. Pyramid Plastics, Inc.

319 Chemical Products Catalog. Dow Chemical Co. will send 38-page catalog with latest information on properties and uses of about 375 basic industrial, pharmaceutical, and agricultural chemicals. Many tables for easy reference.

320 Polyvinyl Alcohol Manual. Comprehensive technical manual on properties and uses of Gelvatol, polyvinyl alcohol, available from Shawinigan Resins Corp. Special section on selected chemical reactions.

321 Technical Data on Zinc Oxides. Applications in rubber, paint, ceramic, other chemical industries. 48-page book from St. Joseph Lead Co.

322 Corrosion-Resistant Coatings. Technical data from Corrosion Control Co. on new Corethylene 100 and 101 corrosion-resistant coatings and linings.

323 Petrochemicals Bulletin. General product bulletin from Amoco Chemicals Corp. describes line of petrochemical products for paint, plastics, rubber, chemical, petroleum, detergent, agricultural chemical, and other industries.

324 Rare Earth Metals. Michigan Chemical Corp., Rare Earths and Thorium Division, announces availability of commercial quantities of gadolinium, dysprosium, erbium, and yttrium.

325 Stabilization of Polyvinyl Chloride. Argus Chemical Corp. offers 23-page technical bulletin on barium-cadmium stabilizer systems and applicability of Argus Mark stabilizers for specific functions.

326 Plastics Reference File. "1958 Condensed Reference File" from Bakelite Co. has thumb-indices to find data on polyethylenes, vinyls, styrenes, phenolics, and epoxies.

327 Peracetic Acid Booklet. Union Carbide Chemicals offers new 48-page brochure on peracetic acid and derivatives. Includes treatise on peracetic acid, reactions of epoxides, extensive bibliography.

328 Protective Coatings. Prices and product information on Copon Associates' line of corrosion-resistant coatings for piping and process equipment.

329 Thermocouple Extension Wire. Bulletin from Claud S. Gordon Co. gives details of Serv-Rite thermocouple cables carried in stock. The wire is now available in multipair cables with over-all polyvinyl sheath.

330 Soluble Silicates Catalog. 16-page folder lists many of the important liquid and dry sodium and potassium silicates with their physical and chemical properties. Philadelphia Quartz Co.

331 Resins and Plasticizers. Pennsylvania Industrial Chemical Corp. offers 12-page brochure with complete property data on coumarone-indene resins, modified styrene resins, and plasticizers. Charts showing phys-

(Continued on page 130)

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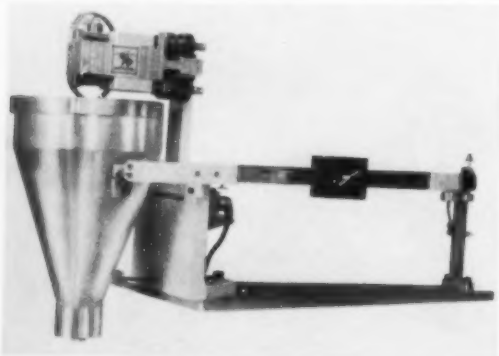
▶ **GET** *up-to-the-minute catalogs, data sheets and bulletins on new chemical products, processes and equipment.*

DEVELOPMENTS OF THE MONTH (Cont.)

407 Automatic Liquid Weighing Unit. Glengarry Processes, Inc. offers a new automatic liquid weighing unit consisting of a weigh tank, mounted on a beam, with an adjustable poise. Above the weigh tank is a specially-designed pneumatically actuated bulk and trim flow valve which is connected to the user's supply tank by silicone or other type of flexible tubing.



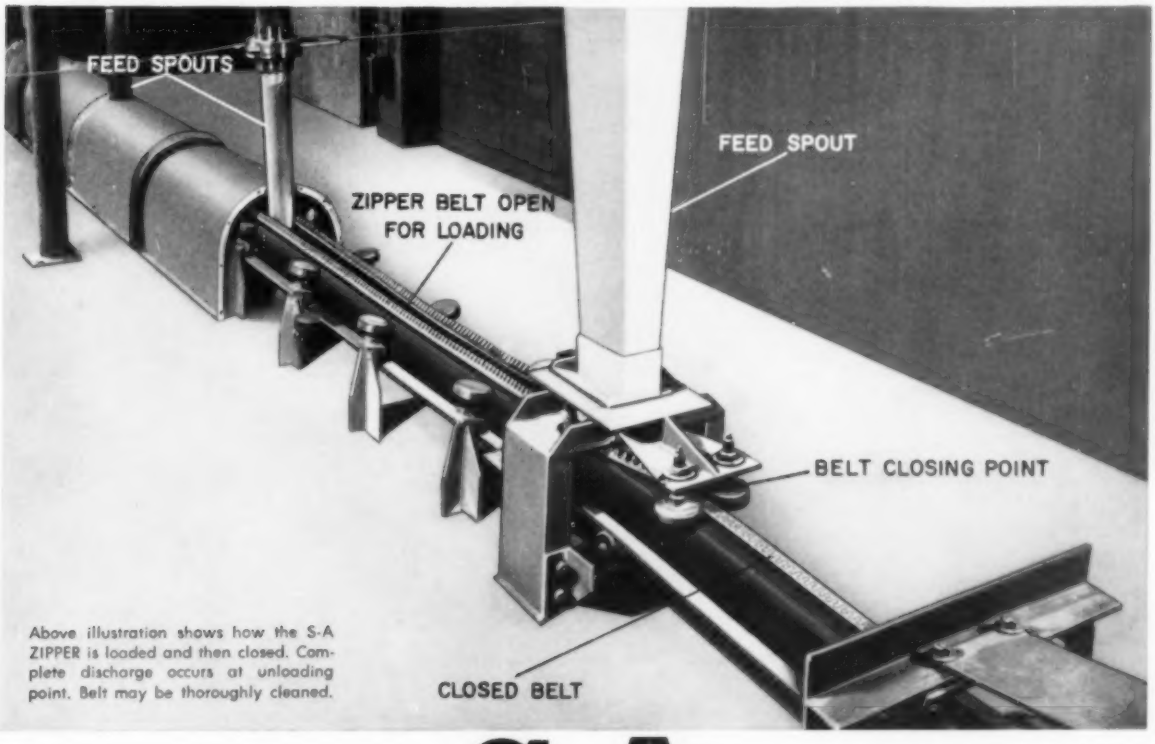
In operation, the poise is first set for the desired weighment, and the control switch turned on. The liquid flows into the tank at a high rate until the set weighment is approached. At this point, the flow is automatically diminished to obtain accurate final weight. When the proper weighment is obtained, the flow valve is positively closed. Impulsing from any desired external source automatically opens the discharge valve and permits the liquid to flow from the weigh tank.

Range is ½ oz. to 10 lb., output is up to 10 weighings per minute. All contact parts are of stainless steel, and all controls are mounted in a remote control box. For further data circle number 407 on Data Post Card.

FRAGILE BULK CHEMICALS ARE HANDLED GENTLY, SAFELY

by "ZIPPER" CLOSED-BELT CONVEYORS-ELEVATORS

NO SEGREGATION — NO DEGRADATION OF MATERIALS



Above illustration shows how the S-A ZIPPER is loaded and then closed. Complete discharge occurs at unloading point. Belt may be thoroughly cleaned.

STEPHEN S-A ADAMSON MFG. CO.

THE BIG NAME IN BULK MATERIAL HANDLING EQUIPMENT

Bulk materials — granular, flaky, pulverized, or small lump, can be conveyed or elevated in any plane, entirely enclosed, and protected by S-A ZIPPER belts. The most delicate materials are moved swiftly and economically, without degradation, or separation.

ZIPPER conveyors require no casing, can be used to carry over long distances, around obstructions in numerous flexible arrangements. The belt simply opens to receive material, then zips closed, sealing its load in a dust-tight casing, moving material within the belt over a system of guide rollers and pulleys to any point of discharge.

The ZIPPER conveyor is exclusively an S-A product. It is ideally suited to materials requiring clean and gentle handling. Belt speeds range up to 200 F.P.M., discharge is possible at any point on horizontal, inclined, or vertical runs.

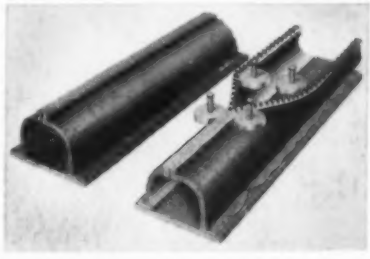
S-A designs and builds conveying systems for all bulk chemical handling requirements. If you have a problem and want expert help, call the S-A sales engineer in your area, or write to any of the main offices listed.

For complete catalog data on ZIPPER conveyors, write for a copy of bulletin 349.

S-A district or main plant offices can supply complete information on any conveyor product, or any phase of chemical product handling. Bulletins on all products available upon request.

MAIN OFFICE AND PLANT
57 RIDGEWAY AVENUE
AURORA · ILLINOIS

PLANTS LOCATED IN: LOS ANGELES, CALIF. CLARKSDALE, MISS. • BELLEVILLE, ONTARIO



Section views thru the endless ZIPPER belt shows how load is completely enclosed. Belt teeth are automatically spread, meshed and locked by means of ball bearing rollers. Material moves forward with belt.

1. Rubber ZIPPER belt open flat for return run and for cleaning.

2. Sidewalls brought into vertical position and ready for loading.

3. Flexible sidewalls completely closed for conveying and elevating.

MATERIALS

(Continued from page 128)

ical and chemical data, melt viscosities, compatibilities, solubilities.

332 Protective Coating Study. 75-page study of the chemistry and physical behavior of cellulose acetate butyrate in protective coatings. Numerous solubility and compatibility charts and tables. Indexed for convenient reference. Eastman Chemical Products, Chemical Division.

333 Mechanical Packings and Gasket Materials. Comprehensive catalog from Raybestos-Manhattan features four pages of packing recommendation charts for rods and plungers, valve stems, centrifugal and rotary shafts.

334 Ceramic Processing Equipment. Catalog from General Ceramics Corp. describes variety of chemical processing equipment in porcelain, stoneware, alumina, Chemplas 15 (furan resin and inert ceramic), and graphite.

335 Beryllium Metal and Oxide. Two bulletins from Beryllium Corp. give physical and mechanical properties, analyses, applications.

336 Stainless and Alloy Tubing. Cold drawn stainless steel tubing, nickel and nickel alloy tubing, small tubular specialties. Bulletin from J. Bishop & Co. Platinum Works.

337 Comparative Properties Chart on Styrene Compounds. Catalin Corp. of America offers chart showing available formulations and granulations of its styrene molding compounds, including general purpose, high flow heat resistant, medium, high, and super high impact grades.

338 Kel-F Plastic Laminate. Bulletin from United States Gasket describes corrosion-resistant laminate claimed applicable to surfaces having almost any contour.

339 High Concentration Hydrogen Peroxide. Physical data, stability, solubility, energy content, hazards, shipping information on hydrogen peroxide solutions of more than 90% concentration. Becco Chemical Division, Food Machinery and Chemical Corp.

340 Acid-Proof Tank Lining. Complete specifications, instructions, and application data on Pyroflex, specially-compounded flexible sheet lining material developed by Maurice Knight Co. Bulletin.

341 Electric Furnace Products. Tabular technical data on silicon carbide, zirconium oxide, zirconium carbide, calcium zirconate, boron carbide, boron nitride, boron, other borides, carbides, nitrides, and fused oxides. Booklet from Norton Co.

342 Catalytic Protective Coatings. Bulletin from Industrial Finishes Co. describes wide range of industrial usage and product adaptability.

343 Cast Alloy Steel Data Sheets. Complete set of 28 data sheets from Alloy Casting Institute give full heat and corrosion resistance data on cast steel alloys. Chemical, physical, and mechanical properties of each alloy are summarized in tabular form.

EQUIPMENT

344 Regulator Valve Sizing Chart. Jordan Corp. offers bulletin showing how to size its OPW sliding-gate regulator valves. Describes adjustments for variations in pressure, temperature, viscosity, specific gravity.

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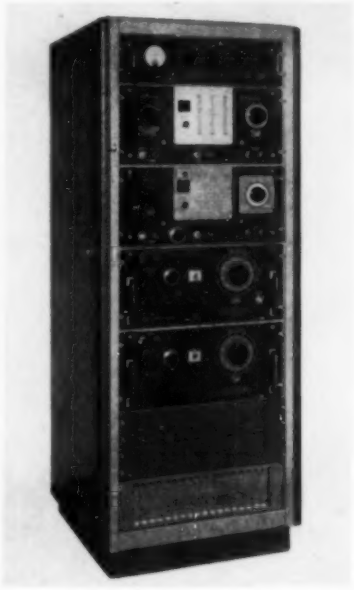
DEVELOPMENTS OF THE MONTH *(Cont.)*



408 Dual Radiation Spectrometer. Model S-13 Dual Peak Spectrometer, made by Technical Measurement Corp., measures accurately the ratio between two separate isotopes in the same radioactive sample. This is accomplished by use of two scalers and two single-channel analyzers, a power supply, linear amplifier, and preamplifier.

Pulses from each isotope are put into separate single-channel analyzers and scalers. The counting periods of the two scalers are both controlled by a single timer which is mounted on one scaler. In addition, a count preset allows the operator to measure directly the ratio between two separate isotopes. When one isotope reaches the preset count, the ratio between it and the other isotope may be measured directly from the precision registers or decade units on the scalers.

The whole unit is mounted in a standard width mobile cabinet with forced air cooling. All systems are shipped complete with interconnecting cables. Price of the unit is $3,560 f.o.b. New Haven, Conn. For further data circle number 408 on Data Post Card.

345 Heavy Duty Rotary Pumps. Capacities to 25 gal./min. Pressures to 500 lb./sq.in. Bulletin from Worthington Corp. gives materials of construction, ratings, describes operating features.

346 Liquid Level Control Booklet. Booklet titled "The Power Plant of Tomorrow" describes use of Magnetrol liquid level and flow controls in the Experimental Boiling Water Reactor at Argonne National Laboratories. Magnetrol, Inc.

347 Rectilinear Galvanometric Recorder. Features error-free trigonometric linkage giving straight line writing motion. Brochure from Texas Instruments, Inc.

348 Turbulent Entrainment Dryer. Said to be an ideal dryer for all types of solids from ½ in. down to very small sizes. Can be fired with powdered coal, oil, or gas. Bulletin from Silver Engineering Works.

349 Vibrating Screens, Feeders, Conveyors. Six-page illustrated folder from Dravo Corp. describes complete line of vibrating screens, feeders, and conveyors manufactured under license from Carl Schenck Co. of Germany.

350 Dehydrator Bulletin. For continuous drying of air and process gases. Brochure describes complete series of standard units, special process units for extreme pressures, high flow rates, minimum pressure drop. Selas Corp. of America.

351 Timer-Controlled Centrifugal. Combines fast bottom discharge with load-centering, mid-point suspension. Technical information from American Machine & Metals, Tolhurst Division.

352 End Suction Pumps. Range of sizes ¼ to 40 hp. at 3,500 rev./min; ¼ to 20 hp. at 1,750 rev./min. 8-page descriptive bulletin from Aurora Pump Division, New York Air Brake Co.

353 Grit Collection Equipment. Booklet from Link-Belt Co. contains design data on seven types of grit collectors, two grit washers, and the Tritor screen, combination grit collector and mechanical screen.

354 Heavy Duty Centrifugal Pumps. Horizontally-split, single-suction pumps with 3, 4, 6, or 8 stages. Capacities from 200 to 2,800 gal./min. Pressures to 1,200 lb./sq.in. Heads from 460 to 2,400 ft. Brochure from Ingersoll-Rand.

355 Mill and Plant Equipment. Crushers, ball and rod mills, vibrating screens, classifiers, feeders, bucket elevators, pumps, thickeners. Bulletin from Denver Equipment Co. gives specifications, capacities.

356 Precision Dry Material Feeders. Vibra Screw feeders are available with capacities from 1 oz./hr. to 100 ton/hr. Accuracy within 1 to 2%. Bulletin from Vibra Screw.

357 Automatic Consistency Controller. The Plastometer, product of Fischer & Porter, controls, measures, records consistency of fibrous or pulpy slurries on automatic continuous basis. In principle, the new instrument is a simple flow bridge—independent of the viscosity of the liquid phase, yet sensitive to concentration of insoluble solids in the slurry. Bulletin.

358 Plate-Type Graphite Heat Exchanger. New "Karbate" impervious graphite heat exchanger features adjustable and removable elbow connection, able to be swiveled to any desired angle. Additional technical data from manufacturer, National Carbon Co.

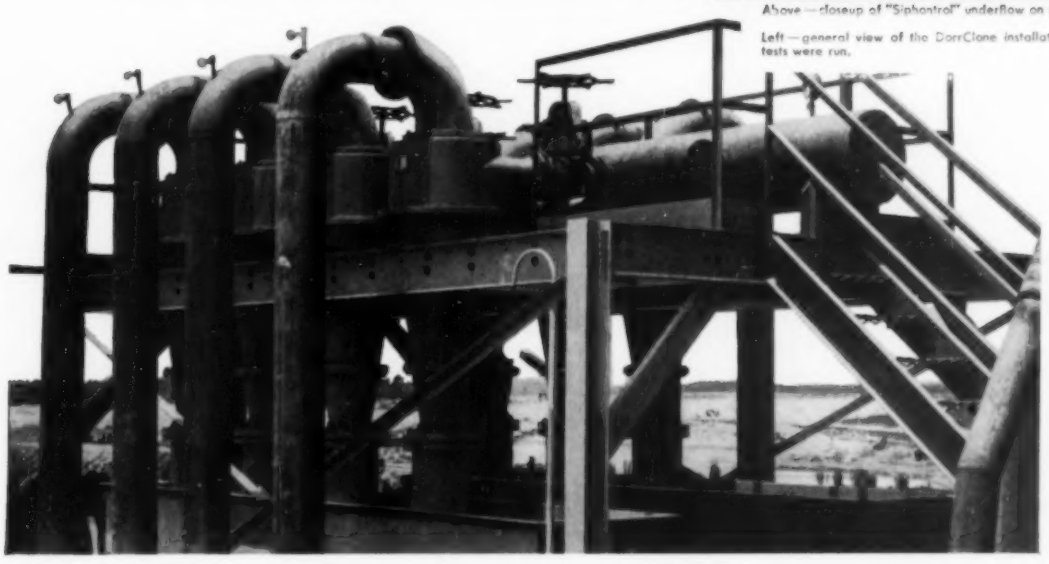
(Continued on page 132)

NOW... Automatic Control of DorrClone Classifier Operation...

Without Instrumentation!

Above — closeup of "Siphontrol" underflow on one unit.

Left — general view of the DorrClone installation on which tests were run.



Latest development in wet cyclone classifiers is an automatic control arrangement that does not require instrumentation. Named the "Siphontrol" underflow control, this new device maintains a reasonably constant underflow density from varying feed solids. Basically it consists of a tail piece extending below the apex valve of the cyclone discharging into a "Saucer" clamped on to this tail piece. The overflow pipe discharge is also submerged using either a saucer device or manifold.

Here are some typical operating results from DorrClone Classifiers in the field equipped with Saucer controls. These units are desliming phosphate rock at one of the mines in the Florida Pebble Phosphate Field. Successive tests were made at five-day intervals. Note the uniformity of separation despite the wide variation in feed composition.

Equipment — Seven 24" dia. DorrClone Classifiers **Control** — "Saucer" Underflow Density Controller

Test No.	1			2			3			4		
	Feed	U'flow	O'flow	Feed	U'flow	O'flow	Feed	U'flow	O'flow	Feed	U'flow	O'flow
Total TPH Solids	601.2	463.4	143.9	325.7	212.1	136.7	302.7	160.4	122.6	785.3	648.7	165.0
TPH + 150 mesh	442.9	449.0	13.5	204.2	202.3	7.0	211.6	148.4	8.0	624.9	615.7	21.5
TPH — 150 mesh	158.3	144.0	130.4	121.5	9.8	129.7	91.1	12.0	114.6	160.4	33.0	143.5
Efficiency												
+150 mesh recovered		97.1%			96.7%			94.9%			96.6%	
−150 mesh eliminated		90.1%			93.0%			90.5%			81.3%	

Tonnages are timed samples and are well within accuracy of method of measurement.

For more information on this new development in wet cyclone techniques, write Dorr-Oliver Inc., Stamford, Connecticut

DORR-OLIVER
INCORPORATED
WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT
STAMFORD • CONNECTICUT • U.S.A.

DorrClone and Siphontrol are trade marks of Dorr-Oliver Inc.

EQUIPMENT

(Continued from page 130)

359 Axial Compressor Bulletin. Basically constant volume with variable pressure output, high efficiency, compact stream-lined design, flexibility, trouble-free operation. In sizes from 8,000 to 1,000,000 cu.ft./min. Allis-Chalmers.

360 Heavy Duty Vertical Mixers. Bulletin with complete description of top and bottom loading units, data on drives and materials of construction, tables showing dimensions and operating speeds. Sprout, Waldron & Co.

361 Self-Priming Rotary Gear Pump. Suitable for non-lubricating and corrosive fluids. ¾ in. inlet and outlet ports, 316 stainless or Hastelloy C housings, Teflon gears and internal bearings and packing. Operates at 1,750 rev./min. with fluids of low viscosity, at capacities to 10 gal./min. and pressures to 100 lb./sq.in. Eco Engineering Co.

362 Dry Separation Equipment. Bulletin from Sutton, Steele & Steele, Inc., gives details of line of vibrating screens, air tables, stoners.

363 High Temperature Fans. Special design makes possible use of carbon steel instead of stainless. Tested up to 1,700° F. Consulting service and recommendations available from Fuller Co., Lehigh Fan & Blower Division. Bulletin.

364 Process Control Instruments. Catalog from Jarco Services, Inc., lists many types of level and interface controls and alarms, solids build-up and contamination alarms.

365 Ultra De-Ionizer. Removes all ionizable impurities including CO_2 and silica, delivering chemically pure water having less than 1 part per million total ionizable solids and showing specific resistance up to 20,000,000 ohms. Folder from Elgin Softener Corp.

366 Vibrating Conveyors. With "Natural Frequency" vibrating conveyors, combination process operations such as screening, drying, dewatering, granulation, and continuous leaching can be accomplished while conveying. Bulletin from Carrier Conveyor Corp.

367 Industrial Dust Filters. Bulletin from W. W. Sly Manufacturing Co. gives comprehensive engineering data and specifications on dust filters. Special section on how to engineer dust control systems.

368 New Type Control Valve Unit. A new composite unit made by the Elsey Corp. is designed to replace the conventional diaphragm control valve installation, either standard or three-way. The unit is composed of three sections: control valve wth top works, plug valve section, and throttling by-pass valve unit. This arrangement replaces the usual control valve installed with a block valve on either side plus a by-pass valve. Further information is available from the manufacturer.

369 Pressure and Liquid Level Transmitter. For pressures to 250 lb./sq.in. or as low as 0 to 100 in. of water. Design of Conoflow Corp's Model "P" transmitter eliminates possibility of measured material backing up into air lines in the event of pressure diaphragm rupture. Bulletin.

370 Gas Turbine Brochure. Describes applications of combustion gas turbines in petrochemical, petroleum, chemical, rubber, and paper industries. Technical data pertains to turbines with range from 6,700 to 30,400 hp., and from 4,750 to 21,800 kilowatts capacity. General Electric Co.

371 Corrosion-Resistant Pump Data. Bulletin from Duriron Co. gives dimension drawings and performance characteristic curves, design data on line of corrosion-resistant centrifugal pumps.

372 Corrosion-Resistant Control Valves. Body, stuffing box, integral seat, and internal ports precision machined from solid block of Teflon, and encased in stainless steel housing. Plug and stem also of Teflon. Catalog page from George W. Dahl Co.

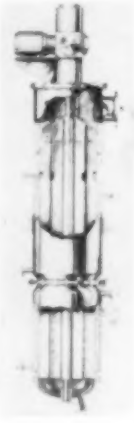
373 Steam Jet Ejector Bulletin. Describes wide range of sizes with single stage or up to six multiple stages. Contains two extensive Dalton's Law charts. Southwestern Engineering Co.

DEVELOPMENTS OF THE MONTH *(Cont.)*

409 Mechanically-Aided Thermal Processor. New catalog from Rodney Hunt Machine Co. describes use of its Turba-Film Mark II Processor in solution of problems involving viscous fluids and time-at-temperature-sensitive materials.

Basic principles of thin-film processing are discussed and illustrated by flow sheets of applications to such processes as concentration, deaeration, distillation, stripping, deodorization, evaporation, desolventization, and homogenization. Given also are graphs of the physical properties and characteristics of viscous liquids.

Included are full technical details of design, engineering, and operation of the Turba-Film Mark II, illustrated by graphic cutaway views. For further details and a copy of the catalog, circle number 409 on Data Post Card.



374 Diaphragm Seals. Designed for protection of pressure instruments against corrosion and clogging. No gaskets or O-rings, no internal threads or blind taps. Over-range protection to 2,500 lb./sq.in. gauge. Bulletin from Brooks Rotameter Co.

375 Cast Stainless Fittings. For service conditions up to 2,500 lb./sq.in. at 670° F. Available in both 300 and 400 series stainless steels in sizes 8 in. to 30 in. including 45 degree and 90 degree elbows, tees, and reducing fittings. Adidtional data from Cooper Alloy Corp.

376 Steam Jacketing for Chemical Pumps. Goulds Pumps Inc., announces steam jacketing for its line of Fig. 3715 chemical pumps. Available in all sizes for steam pressures to 100 lb./sq.in. or 338° F. saturated steam. Technical data from the maker.

377 Glass Pipe and Fittings Manual. 44-page booklet from Corning Glass Works contains design information, engineering recommendation instructions on Pyrex Brand glass pipe and fittings.

378 Level Control Booklet. 16-page brochure from Robertshaw-Fulton Controls Co. covers applications of capacitance-type devices in quantitative measurement and control of granular solids, liquids, powders, and interface.

379 Centrifugal Screening Unit. Dorr-Oliver offers bulletin describing operation, design features, advantages, and specifications of newly-introduced centrifugal screening unit.

380 High Vacuum Gauges. Absolute manometers, thermal gauges, ionization gauges, combination thermal-ionization gauges. Bulletin from Consolidated Electrodynamics, Rochester Division.

381 Mixer- Disperser-Kneader. Can handle materials ranging in consistency from soft paste to heavy, tough dough. In pilot plant and industrial sizes. Bulletin from Bramley Machinery Corp.

382 Turbine Type Flowmeter. The Potter Electronic Flow Sensing Element utilizes the hydraulic pressure of the measured fluid itself to suspend a turbine-type rotor in an axial "floating" position, eliminating thrust friction. Bulletin from Potter Aeronautical Corp. gives volumetric and gravimetric flow ranges.

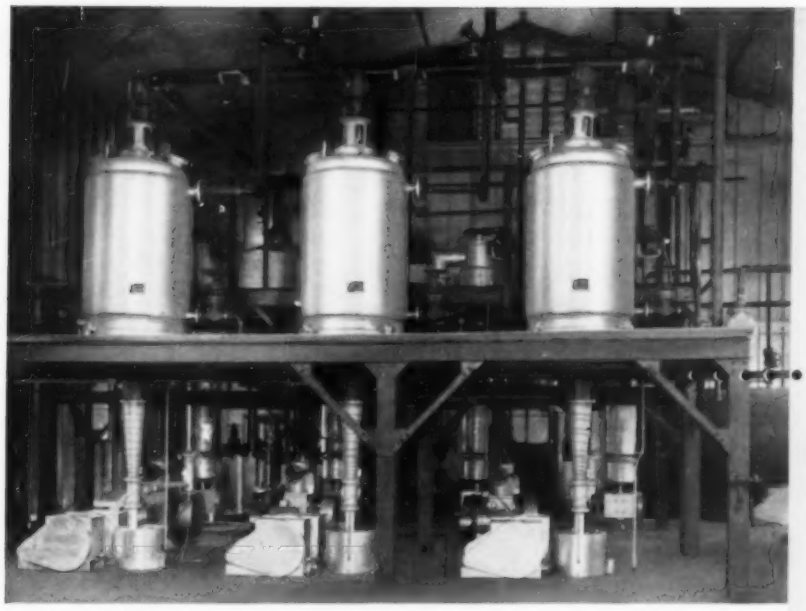
383 Specialized Process Equipment. Mixers, kettles, vacuum and pressure vessels, autoclaves, evaporators, impregnators, condensers, stills, extractors. Bulletin from L. O. Koven & Brother, Inc.

384 Hydraulic Filter Press Closer. Converts any mechanically operated plate and frame filter press to hydraulic closing. Free testing

(Continued on page 134)

○ **CIRCLE** *your Data Service requests on the handy postcard on page 124 to*

▶ **GET** *up-to-the-minute catalogs, data sheets and bulletins on new chemical products, processes and equipment.*



Paraffin at a Fraction of a cent Per Pound!

Three Asco Molecular Stills at Trans Penn Oil Co. Can Produce More than One Tank Car Per Day

ASCO ROTA-FILM

The Only Molecular Still Sold on a Royalty-Free Basis

are you the 1 in 20 who knows how*

MOLECULAR DISTILLATION

can increase profits?

If you are that one, you know that Molecular Distillation can process organic compounds with molecular weights from 200 to 1250 and silicones and halocarbons to 4000.

This means that a broad range of processes can be carried out with *better results* and at *far less initial cost and far less operating cost* than by methods commonly used. Here are a few such processes:

- Vitamin Recovery from Natural Triglycerides
- Purification of Monoglycerides
- Isolation of Natural Oil Components
- Distillation, Decolorizing, Recovery
- Purification of Pharmaceuticals
- Removal of odors, colors and non-saponifiables from crude tall oil, fatty acids and materials of higher molecular weights in general.

Results and savings are often startling. For example, a leading pharmaceutical manufacturer *produces a tranquillizer from compazine base* (a previous impossibility) using an Asco Molecular Still—weekly savings more than equal still cost, and the product is purer! . . . A French chemical producer *distills electrical grade dioctyl phthalate* of high quality on a commercial scale. . . . A U. S. company de-glycerinates glyceride mixtures with remarkable economy, just one of the separations and distillations of glycerides possible with Asco Molecular Stills.

Many more similar cases can be cited in which Asco Molecular Distillation has increased profits, improved results.

*Based on Recent Survey of Chemical Engineers

Check These Asco Features:

- ☐ Capacity Per Unit Practically Unlimited
- ☐ Present Personnel Can Operate
- ☐ Accelerated, Turbulent Film
- ☐ Shorter Exposure Time
- ☐ Minimum Pressure Drop
- ☐ Largest Possible Open Path

Test at Low Cost!

A laboratory size Asco Rota-Film Molecular Still is now available. This permits inexpensive tests accurately transferable to Asco industrial models. Price is $391.

New Brochure

Fully Describes Models and Applications

TEST RUN SERVICE

Now you can have test runs and limited custom distillation performed at ASCO's Rochester plant. Cost is $125 per day. Write for complete details . . . Dept. CEP-2.

a|s
c|o

ARTHUR F. SMITH COMPANY

311 ALEXANDER ST. • ROCHESTER 4, N. Y.

EQUIPMENT

(Continued from page 132)

service offered by Biach Industries, Inc. Bulletin.

385 pH Equipment Brochure. New 8-page bulletin "Beckman Industrial pH Equipment" gives detailed descriptions and specifications of pH instruments, electrodes, and accessories. Beckman, Process Instruments Division.

386 High Temperature Plastic Diaphragm Valve. Made of Penton, a new diaphragm valve developed by Hills-McCanna will operate at 300° F. with a chemical resistance approaching that of glass. Bulletin.

387 Pipe Line Filters. Bulletin from the Dollinger Corp. gives specifications and capacities of Staynew pipe line filters.

388 Heat Exchangers. BCF exchangers, product of Ross Heat Exchanger Division, American-Standard, are now available in 46 sizes; one, two, and four pass designs; and 1.2 to 124 sq. ft. of heat transfer surface. Bulletin.

389 Explosion-Proof Motors. Fairbanks-Morse & Co. offer a new line of totally-enclosed, explosion-proof motors. Fan-cooled and non-ventilated models built to latest NEMA standards.

390 Low Level Condenser Data. Application, construction, and operation information on low-level educator and multi-jet condensers. Complete sizing data, capacities, weights, and dimensions in tabular form. Schutte and Koerting Co.

391 Liquid Metal Pump. Designed to circulate liquid metals through the hermetically sealed system of certain types of nuclear power plants. Available in capacities from 150 gal./min. to 5,000 gal./min. at temperatures to 1,600° F. Westinghouse Electric Corp.

392 Continuous Cooling and Flaking Process. 18-page bulletin from Buflovak Equipment Dvision, Blaw-Knox Co., gives mechanical descriptions and specifications of Buflovak flakers, twin and double drum flakers, Roto-Shelf coolers, pilot plant flakers, and cooling drums.

393 Metering Pump with Diaphragm Liquid End. Bulletin with capacities, pressures, and materials of construction of leakproof pump for metering corrosive, obnoxious, or toxic chemicals. Milton Roy Co.

394 Impervious Graphite Heat Exchange Equipment. Bulletin on heat exchangers, immersion heaters, and jet agitators constructed of impervious graphite. Flow rates and effective heat transfer areas for standard multiple tube and concentric tube exchangers of various sizes. Heil Process Equipment Corp.

395 Combustible Gas Analyzer. Designed to provide flexible, centralized instrumentation for process control and industrial safety. Information from Mine Safety Appliances Co. on its model "F" Analyzer.

396 Sifters and Gyrating Screens. Specifications on 18 different models of "Ro-Ball" sifters and gyrating screens contained in bulletin from J. H. Day Co.

397 Electromagnetic Vibrator. Data and specifications from Syntron Co. on new, small Model V-2 electromagnetic vibrator, designed for controlled vibration of dispensing hoppers and parts-feed tracks of processing and packaging machines.

398 Engineering Data on Flow Meters. 22-page bulletin gives basic technical information and theory on selection, sizing, and installation of various types of differential pressure type flow meters. Bristol Co.

BASIC THEORETICAL PAPERS

in chemical engineering appear quarterly in the A.I.Ch.E. Journal, published by the American Institute of Chemical Engineers. For further information, circle number 410 on Data Post Card.

SERVICES

399 Filter Area Calculator. Pocket size calculator makes possible rapid determination of square feet of filter area required in liquid-solids separation. Free from Niagara Filters Division, American Machine and Metals, Inc.

○ **CIRCLE** *your Data Service requests on the handy postcard on page 124 to*

▶ **GET** *up-to-the-minute catalogs, data sheets and bulletins on new chemical products, processes and equipment.*

400 ASME Code Index. Downingtown Iron Works, Inc. offers handy reference index to the ASME Boiler and Pressure Vessel Code, Section VIII (Unfired Pressure Vessels).

401 Radiation Research Service. For all types of applied nuclear research and radio-analytical problems. Brochure from Controls for Radiation, Inc. Also hazard protection service.

402 Test Equipment for Petroleum Industry. Data sheets from Artisan Metal Products, Inc. detail their facilities for design and fabrication of special and production equipment.

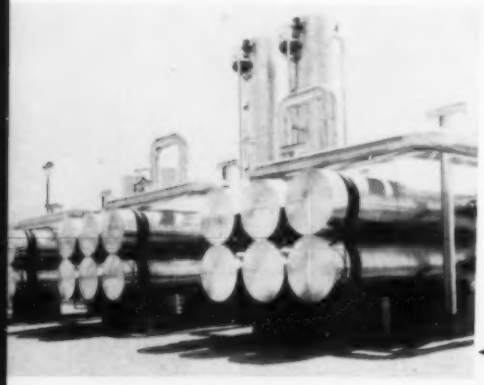
403 Nuclear Design Services. From specialized laboratory services to complete design, construction, startup, and operation of reactors of practically any type. Brochure from Curtiss-Wright Corp.

DEVELOPMENTS OF THE MONTH *(Cont.)*

411 Models. M. W. Kellogg Co. offers Kelloggram No. 5, 1957, a brochure "Models: New Route to Better Plant Design," describing its new system of planning with fully-scaled, three-dimensional models. A recent company development program was directed toward the extensive use of models to achieve the following objectives:

- Build a functional model; a model that would proceed concurrently with design; a model whose construction techniques would not require specialists; a model that could be easily changed and revised.
- Eliminate study and layout drawings by designing directly on models.
- Prepare fabrication and construction drawings from models.
- Substitute photographs and machine operations for fabrication and construction drawings.

The brochure shows how Kellogg has used models to resolve questions of plot arrangement, equipment handling, process flow, plant operation, and plant maintenance by citing actual case histories. It describes a new rapid, push-fit model-making technique which simplifies model construction, permits design personnel to work directly on the model, and results in a single progressively advancing model which is representative of the design in any stage. To obtain a copy of this brochure, circle number 411 on Data Post Card.



Heat exchangers are sheathed with aluminum over Ehret double-layer Thermalite magnesia insulation.

MAGNESIA INSULATION FOR SAVINGS AND SAFETY

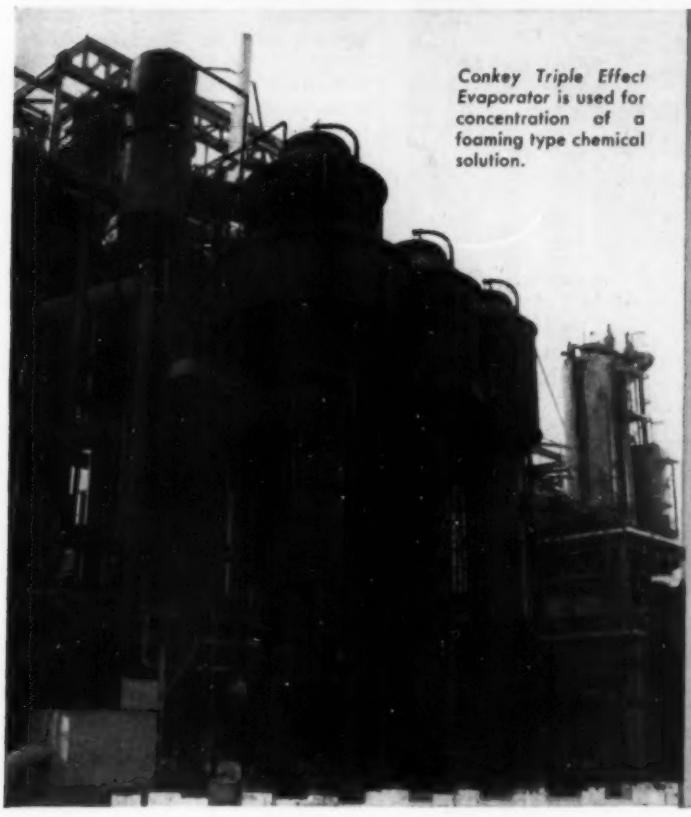
(Continued from page 123)

⅛ in. thick asphalt weatherproofing. Finally, each vessel is covered with a jacket of 0.024 in. corrugated aluminum sheet. Sheets are lapped at least 3 in. at seams, and are held together with aluminum screws on 4-in. centers.

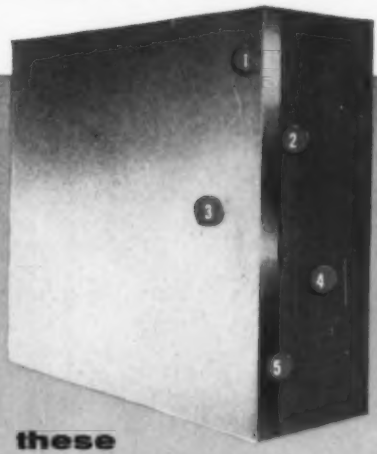
Further information on Thermalite insulation is available from the manufacturer. Circle number 405 on Data Post Card.

CONKEY® EVAPORATOR

is INCONEL HORTONCLAD® throughout



Conkey Triple Effect Evaporator is used for concentration of a foaming type chemical solution.



these benefits with HORTONCLAD

1. UNIFORM THICKNESS
2. HIGH STRENGTH BOND
3. CLEAN, CONTAMINANT-FREE SURFACE
4. ADAPTABILITY TO ANY SIZE OR SHAPE
5. SPECIAL COMBINATIONS OF METALS AVAILABLE

This 3-body triple effect LTV Integral type Conkey Evaporator was fabricated to ASME code throughout in Hortonclad Inconel construction. It is fitted with a two pass, first effect body—complete with a barometric condenser.

A foaming tendency of the chemical solution being concentrated is minimized by use of Conkey patented, built-in preheater sections. This permits each evaporator section to operate on liquors that have been heated to boiling temperature in that body. Economy of operation is insured by use of an external liquor-to-liquor heat exchanger built in multiple sections—so that one section can be cut from the system for cleaning, while balance of system remains in operation.

Compact, unitized "out-of-door" construction such as this is another example of how Conkey "know-how" is helping progressive processors realize the benefits of low installation and erection costs and maximum use of space.

CC39C

Conkey crystallizers, for batch or continuous operation, are fabricated by CB&I in four strategically located, completely equipped plants. Laboratory facilities are available for pilot testing. Write our nearest office for details.

Conkey® Equipment includes:
Crystallizers • Evaporators • Filters

CONKEY EQUIPMENT (CB&I)

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Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY, GREENVILLE, PA. and NEW CASTLE, DEL.

REPRESENTATIVES AND LICENSEES:
Australia, Cuba, England, France, Germany, Italy, Japan, Netherlands, Scotland

New Bulletin 18RG describes SK's line of "Safeguard" Rotameters and gives detailed instructions for liquid and gas sizing. A special sheet lists fluids for which PVC is recommended. Send for your copy.

SK "Safeguard" Rotameters with Polyvinyl Chloride (PVC) end fittings are now available for measuring the flow of hydrochloric acid, sulphuric acid, and the many other chemicals for which PVC is recommended. As a matter of fact, these new Rotameters are already being used for corrosive fluid service with excellent results.

Two facts regarding this new PVC "Safeguard" Rotameter are of particular importance.

First, this instrument provides a Rotameter with chemical resistant end fittings and rotor at much less cost than a similar instrument with these components made of other special corrosion resistant materials.

Second, the Fig. 18275 "PVC" Rotameter incorporates all of the features of the SK "Safeguard" line—one piece fabricated steel case, tube and rotor versatility, heavy safety glass windows, adaptability to panel mounting and to electric or pneumatic transmission for remote recording and controlling of fluid flow, and others.

Schutte and Koerting COMPANY

INSTRUMENT DIVISION

2245 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

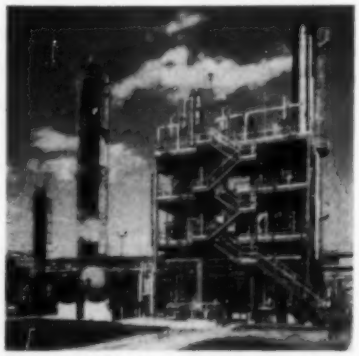
INDUSTRIAL NEWS

A complete line of high-quality catalysts and technical and application information is offered by newly-formed Catalysts and Chemicals, Inc., Louisville, Ky. According to company officials, extensive catalyst manufacturing facilities are being installed in Louisville, production of metal and metal oxide catalysts will be underway soon. □

A contract in excess of $2,000,000 to design, engineer, and construct a 275,000 lb./hr. steam generating plant and attendant facilities has been awarded to Fluor Corp. by Standard Oil of California. The new plant, located at Standard's El Segundo, Calif., refinery, will form part of an existing catalytic cracking unit, will burn both natural gas and catalyst regenerator flue gas. Construction start is scheduled for August, 1958, completion for March, 1959. □

First digital computer said to be capable of fully-automatic control of a petroleum refining process has been purchased by the Texas Co. The computer, Ramo-Woolridge's RW-300, will control the petroleum refining process on a polymerization unit at Texaco's Port Arthur, Texas, refinery. □

A forty per cent minority interest in National Petro-Chemicals Corp. has been acquired by National Distillers and Chemical Corp., making the firm a one hundred per cent-owned subsidiary of National Distillers. National Petro owns and operates a large petrochemicals plant in Tuscola, Ill., has announced construction of a polyethylene plant in Houston, Texas. □



Final purification of polyethylolpropane chemical intermediate occurs in this vacuum distillation stage of Celanese' new production unit at Bishop, Texas. The plant has an annual production capacity of over 10 million pounds, and because of unusual flexibility, can also be used to produce trimethylolethane, neopentylglycol, and other aldol products.

MACH 5...

with the help of

ADSCO CORRUFLEX EXPANSION JOINTS

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YUBA

YUBA CONSOLIDATED INDUSTRIES, INC.

Wind rushing through a wind tunnel at the Arnold Engineering Development Center, Tullahoma, Tenn., reaches a speed of five times the speed of sound. That is 3800 miles an hour. Under this condition, this Air Force Research and Development Command Center can test aircraft, missiles and projectiles under simulated characteristics of high-speed flight.

But the air-supply ducting grows and twists under the high temperatures and pressures of the air rushing inside. Something must absorb this movement occurring in three directions, or the ducting would buckle. Easily and efficiently, the movement is absorbed by a combination of Adsco Corruflex Hinge and Universal Expansion Joints, shown above in a section of the ducting.

The design and development of these expansion joints to customer's specialized requirements is only one of the many engineering feats performed by Adsco in recent years. Consult Adsco the next time you need help on piping engineering.

PROCESS CONTROL ENGINEERS
— much in demand, but supply short

Need for chemical engineers trained in automatic process control techniques is growing rapidly; the supply is alarmingly low. An A.I.Ch.E. subcommittee is now making a full-scale study of this urgent problem.

Many chemical companies, especially the larger ones, have organized separate company units to study the application to chemical processing of advanced control systems and new methods for studying the response of physical systems. However, more extensive application of these principles and methods of study is presently hindered by an extreme shortage of chemical engineers who also have the required background in mathematics, computer techniques, and control systems.

Bottleneck

The need is urgent for a practical program to overcome this shortage. Education is the bottleneck. Problems faced by the colleges in offering such courses are formidable:

- **Finding room in their present curricula or deciding which present courses the new material should replace;**
- **Determining the proper mathematical level at which such material should be presented;**
- **Finding instructors who themselves have a background and an interest in the field;**
- **Procuring the necessary computing and laboratory equipment;**
- **Developing problems and examples of application to the chemical processing field.**

Against the background of an undoubted shortage in industry of chemical engineers trained in automatic process control, the Educational Subcommittee for Process Control (A.I.Ch.E.)* was formed in July, 1957, through the efforts of Dave Boyd, UOP, and Ted Williams, Monsanto. Purpose was to study the proper place of process control and systems engineering courses in the regular chemical engineering curricula of our universities. Almost complete survey results (94% as of December 10, 1957) now make possible a preliminary evaluation of what our engineering colleges and universities are doing and thinking about the subject.

First step in the A.I.Ch.E. committee program was to draw up a questionnaire which was sent to the chemical engineering departments of each of the country's colleges and universities. A second questionnaire has been prepared and will be distributed shortly to a wide range of chemical companies to determine their actual need for personnel with training in the automatic process control and systems engineering field.

Out of 117 schools contacted in the educational survey, 110 have sent back completed questionnaires. Less than half (49%) already have some kind of process control or process instrumentation courses in their undergraduate curricula, or expect to have them in the near future. Only 24.5% have, or expect to have, such courses for graduate students. Eleven per cent of these schools are equipped to give separate courses to undergraduate and graduate students. Twenty one of the undergraduate courses have an associated laboratory, only 5 of the graduate courses do.

Emphasis on Differential Equations

The place of differential equations in the undergraduate curriculum was emphasized in the questionnaire. Thirty four schools (64%) stated that a course in differential equations preceded the process control course, seven additional schools required it as a concurrent course. Ten schools do not require differential equations, while two more teach the subject after the control course. Seven schools require also the study of the theory of complex variables. Asked whether students were encouraged to avail themselves of the opportunities for advanced study in control theory in the school's electrical and mechanical engineering departments, ten schools replied in the affirmative, and 28 schools said no.

Sixteen schools felt that process control and instrumentation were already adequately covered by other courses in the curriculum such as unit operations, plant design, and kinetics. Eleven of the schools without such a program indicated their *desire* to start as soon as possible. Fourteen stated that the only obstacle was finding an adequate and qualified teaching staff. Thirteen others recognized the desirability of the course, but considered their chemical engineering curriculum so full that they could not find room for it.

Objection on Principle

Certain professors expressed the firm opinion that the undergraduate course should specialize in fundamentals and therefore should not teach an applications course such as plant instrumentation. Others felt that such training was adequately handled in the electrical and mechanical engineering departments and that, therefore, it was not a proper subject for chemical engineering departments.

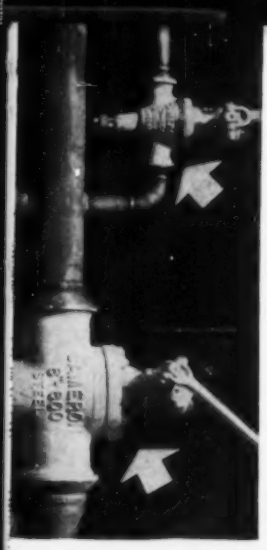
Further Committee Objectives

In addition to making surveys, the A.I.Ch.E. committee is moving ahead along several other related routes to the same objective. They intend:

- **To prepare a list of suggestions for material to be included in a process control course;**
- **To prepare a sample course outline for a course to be given to junior and senior undergraduate students;**
- **To prepare a sample course outline for a course to be given to graduate students;**
- **To collect and distribute sample problems and other material of value in the above courses.**

Each of the 70 schools which indicated that they either teach or plan to teach process control courses was asked to send to the committee copies of any class notes, problems, or course outlines which they had available. So far, 13 schools have submitted a considerable amount of such material. It is hoped that many more will follow their example. This material will be edited and redistributed to the colleges and universities to assist them in presenting their individual courses. The committee wishes to emphasize that it has no intention of attempting to dictate to the instructor how to set up and run his course. Its work in this field is intended only to help him in making his own decisions more readily.

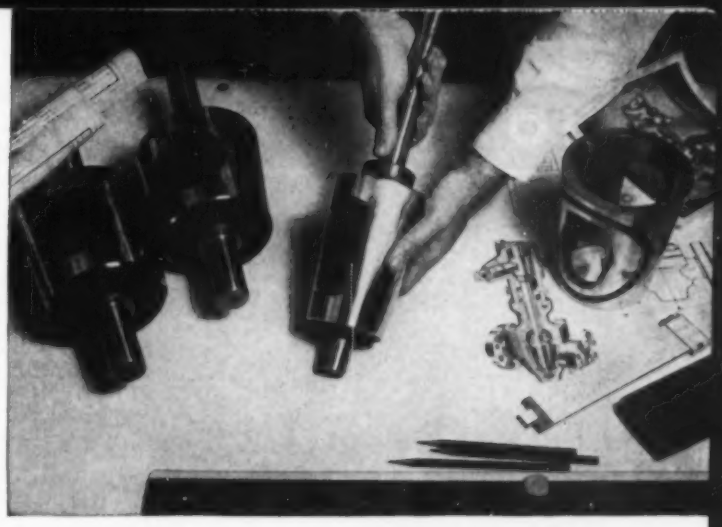
*** T. J. Williams, Monsanto Chemical Co., chairman; J. H. Blake, Univ. of Colorado; N. H. Ceaglske, Univ. of Minn.; E. F. Johnson, Jr., Princeton Univ.; W. F. Stevens, Northwestern Tech. Inst.; B. S. Swanson, Ill. Inst. of Tech.; O. L. Updike, Univ. of Virginia.**

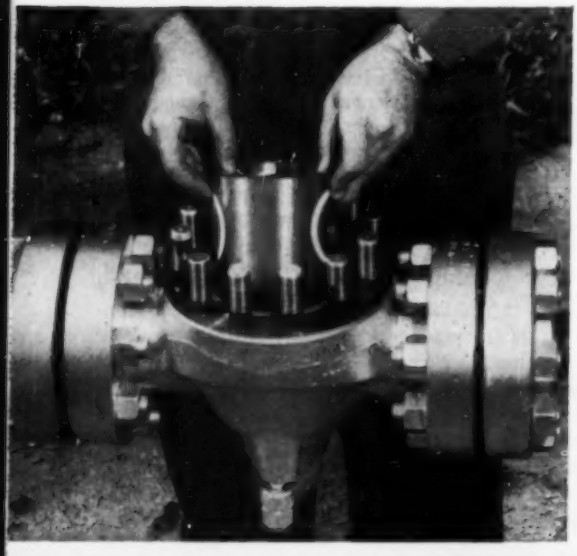


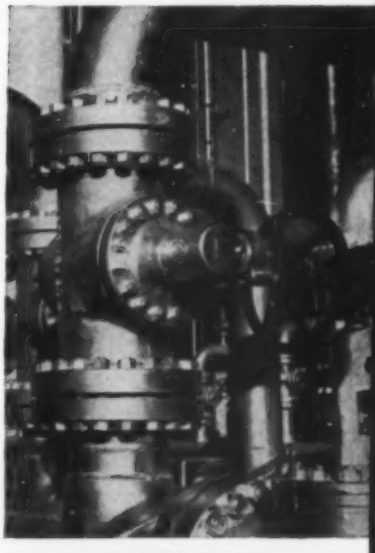
SMOOTH DESIGN

The sealing surfaces of Cameron Non-Lubricated Lift-Plug Valves are smooth—so smooth they require no greases, no expensive lubrication program to maintain a perfect seal. They close bubble-tight on today's elusive, high pressure fluids and gases.

The unusual Cameron Lift-Plug design eliminates friction because the plug is lifted from the seat before rotating—actually never touches the seat except when completely open or closed. Unlike ordinary valves, Lift-Plugs employ a removable seat which is sealed off from the body and will not reflect pressure distortions. As an added benefit, this makes possible special trims for a wide range of services and temperatures — stainless steel for corrosives, Hycar for LPG, etc.



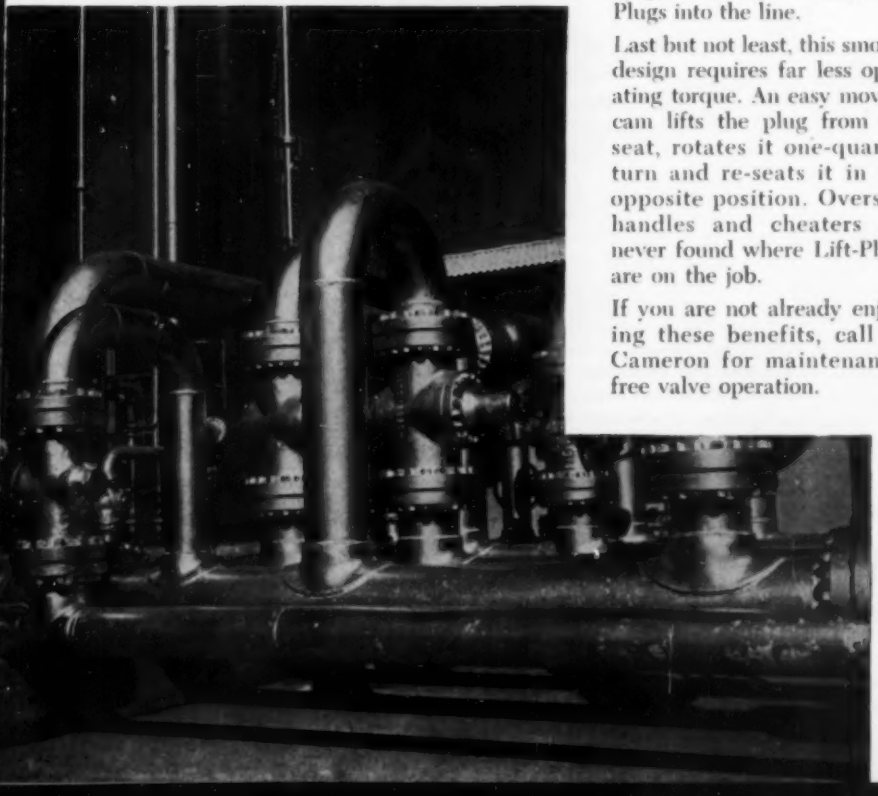




When repairs are finally necessary the seat and plug may be easily replaced without removing the valve from the line. Flanges and connection leaks can be eliminated by permanently welding Lift-Plugs into the line.

Last but not least, this smooth design requires far less operating torque. An easy moving cam lifts the plug from the seat, rotates it one-quarter turn and re-seats it in the opposite position. Oversize handles and cheaters are never found where Lift-Plugs are on the job.

If you are not already enjoying these benefits, call on Cameron for maintenance-free valve operation.



Cameron

IRON WORKS, Inc.

P. O. Box 1212 — Houston, Texas

Export Office: 7912 Empire State Bldg., New York City. In England: Cameron Iron Works, Ltd., Time & Life Bldg., New Bond Street, London W. 1 England

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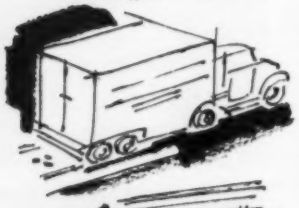
Call Cambridge

for

INDUSTRIAL WIRE CLOTH AND SCREEN

Bulk or Fabricated Parts

INQUIRIES ARE ANSWERED PROMPTLY—Whenever you call or write for information on prices, availabilities or service, you get a prompt reply.



DELIVERIES ARE MADE ON TIME—Orders for the most frequently used types of wire cloth are promptly filled. If we can't supply what you want from our complete stock, we'll schedule our looms to get it to you as soon as possible.

INSTALLATIONS ARE CHECKED—At Cambridge, orders aren't filled and forgotten. Our own sales engineers follow up your order to make sure our product is giving you the best possible service.

QUALITY, OF COURSE—Individual loom operation and countless checks on mesh size and mesh count assure you of highest quality wire cloth when you specify Cambridge.

Let us quote on your bulk or fabricated wire cloth needs. Samples for inspection or test purposes are available upon request. Call your Cambridge FIELD ENGINEER. He's listed in the phone book under "Wire Cloth." Or, write direct for FREE 94-PAGE CATALOG and stock list giving full range of wire cloth available. Describes fabrication facilities and gives useful metallurgical data.

The Cambridge Wire Cloth Co.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

Department 1, Cambridge 2, Maryland

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

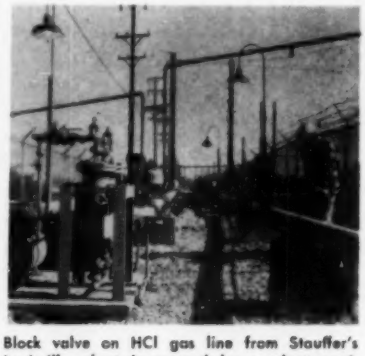
INDUSTRIAL NEWS

A large alkylation unit—10,000 b/d of motor alkylate—will be designed, engineered and constructed by Foster Wheeler at Esso's Baton Rouge refinery. The plant is said to be a duplicate of one now under construction at Esso's Bayway, N.J. refinery. □

Three engineering contracts, totalling approximately $1,500,000, have been awarded to Fluor Corp. by Pontiac Refining Corp. First contract calls for redesign and modification of the No. 2 crude unit at Pontiac's Corpus Christi refinery to permit super-fractionating of 10,000 b/d of sour crude. A 5,000 b/d naphtha Unifiner will also be engineered and constructed by Fluor at the Corpus Christi site. Third contract covers study of a gas recovery plant to determine the most economical method of modifying it to handle miscellaneous refinery gas streams now going to fuel gas. □

"Panama may become a major source of the primary ore used for production of aluminum," says Kaiser Aluminum & Chemical Corp., announcing its success in obtaining a bauxite exploration and mining concession from the Government of Panama. According to Kaiser, preliminary studies indicate extensive deposits in a large area of western Panama near the Costa Rican border. □

A substantial price reduction on ammonium perchlorate, major ingredient of high-performance solid propellants for rocket engines, is announced by American Potash & Chemical. New base price is 34¢/lb., down 12 per cent from 38.7¢/lb. □



Block valve on HCl gas line from Stauffer's Louisville plant is opened by a plant engineer. Already supplying DuPont, Stauffer split its line to supply B. F. Goodrich's nearby PVC installation. Because of the practicality of having the metering station close to the point of delivery, the flow is electronically controlled at the plant 2½ miles from the point where the line splits.

A WORLD OF EXPERIENCE

IN PROCESS PLANTS . . .

FOSTER WHEELER
in Texas

At Baytown — most advanced design fluid catalytic cracking unit — capacity, 55,000 barrels per day.

At Beaumont — ultra-modern crude unit — capacity, 100,000 barrels per day.

At Houston — complete petrochemical plant to produce ammonia and methanol.

Foster Wheeler's Houston Office provides complete engineering, drafting, purchasing, expediting and construction services for process industries in the Gulf Coast area.

FOSTER WHEELER CORPORATION
666 Fifth Ave., New York 19, N. Y.

Advanced-design fluid catalytic cracking unit under construction by Foster Wheeler at Baytown, Texas. Structure supporting high crane will be a permanent elevator tower for servicing the cracking unit.

DESIGN
ENGINEERING
CONSTRUCTION

Petroleum Plants
Petrochemical Plants
Chemical Plants

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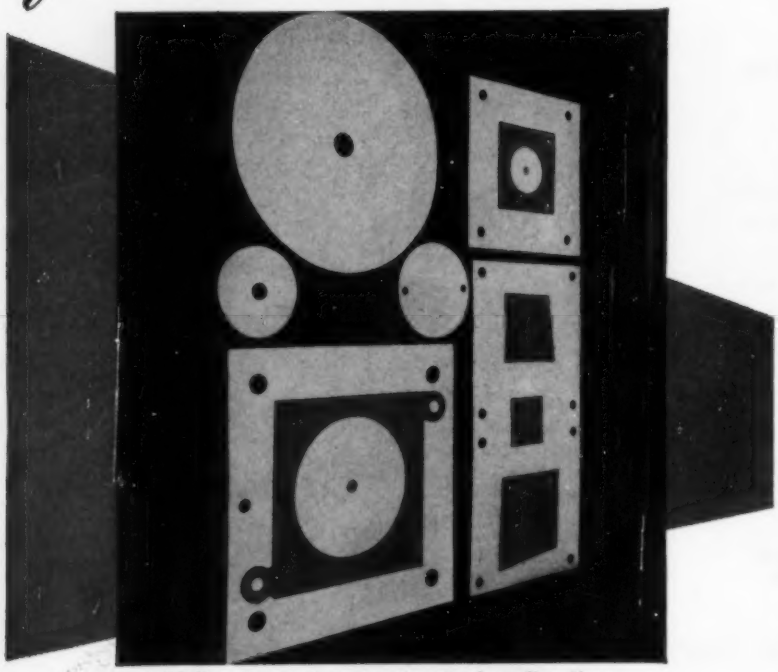
Exceptional clarity of filtrate obtainable.



E-D filter papers cut to exact requirements of your filter. Above are a few of the most widely used sizes and shapes.

In most cases, E-D filter papers can obtain greater clarity of filtrate than is possible with any other filter media.

First, because of their fine porosity. Second, because superior raw materials and rigid production controls result in papers of unmatched purity and quality.

In addition, leading filter manufacturers recommend the use of E-D filter papers as

Time saving: Little or no recirculation is required when used with filter aids.

Labor saving: Easy to handle, easy to dress, easy to remove.

Versatile: Can be used with equal efficiency over filter cloth, metal screens, or perforated plates.

E D *The Eaton-Dikeman Company*

FILTERTOWN
MT. HOLLY SPRINGS, PENNA.

FREE! *Write for new Catalog 357 showing extensive use of industrial filter papers in plant applications.*

INDUSTRIAL NEWS

Contract for the seventh-phase construction of the Navy-Callery Chemical Co. high-energy fuels plant has been awarded to joint bidders. H. K. Ferguson and Macco construction companies jointly bid low at $10.3 million for the building phase to include several process units, steam boiler plant, engineering building and laboratory, and other construction necessary for the completion of the plant. □

The first interstate pipeline for transporting high-purity ethylene will link Petroleum Chemicals' soon-to-be-completed 200 million pound ethylene plant in Lake Charles, La., with the processing facilities of two contract customers in Orange, Texas — DuPont and Spencer Chemical. □

A new plant for the production of 36 per cent zinc sulfate for agricultural and industrial use has been completed by the Chemical & Pigment Co., Oakland, Calif. □

Pollucite, the principal ore of cesium, will be mined and sold at the rate of 1,000-3,000 tons/year, says Montgary Explorations Ltd., Toronto. Ionized cesium is said to be of increasing interest today as an ultra-energy fuel source to power missiles in outer-space flights. □

Latest entry into the chemical field is the Scott Paper Co. which will market a new type of urethane foam for insulation, cushioning, filtration and other industrial uses. □

Ultra-pure single-crystal silicon, polycrystalline silicon, and related products will be in full production within a year at the now-under-construction Cherokee plant of Merck & Company at Danville, Pa. Initial production will start January 1958. The silicon will be processed by Merck under special license agreements with the West German firms Siemens & Halske and Siemens-Schuckertwerke.

120-foot-long deethanizer tower starts its trip from the Delta Tank Mfg. Co., Baton Rouge, to a Texas petrochemical plant. Built by Delta, the tower was engineered by M. W. Kellogg.

Why **DYNALOG*** *design is out front of all electronic potentiometers . . .*

IT GIVES STEPLESS, CONTINUOUS BALANCING!

Advance features to improve control of temperature, pressure, flow . . .

1. No periodic maintenance
2. No dry cell—no standardizing
3. No high-speed moving parts
4. No slidewire or galvanometer
5. *Stepless*, continuous balancing
6. Adaptable to narrow spans

FOXBORO
REG. U.S. PAT. OFF.
DYNALOG
ELECTRONIC INSTRUMENTS

Here's precision in motion . . . the smooth, continuous balancing action of a Dynalog Electronic Instrument! No slidewire with faltering step-by-step inaccuracies . . . no sliding or rubbing contacts. Instead, a simple, variable, radio-type capacitor and positive magnetic drive. It's friction-free, wear-free.

That's why Dynalogs respond almost instantly to the slightest change in a process variable, with a sensitivity of 1/100 of 1% of scale . . . accuracy of ¼ of 1% of scale. It's also the reason they're the maintenance man's dream. About all he does is supply ink and charts!

Dynalogs are used with any primary element—resistance, voltage, capacity, inductive. They perform with effortless accuracy, even on control and recording problems that conventional balancing-type instruments can't handle. For the complete story, write for Bulletin 20-10. **The Foxboro Company, 932 Neponset Avenue, Foxboro, Mass., U.S.A.**

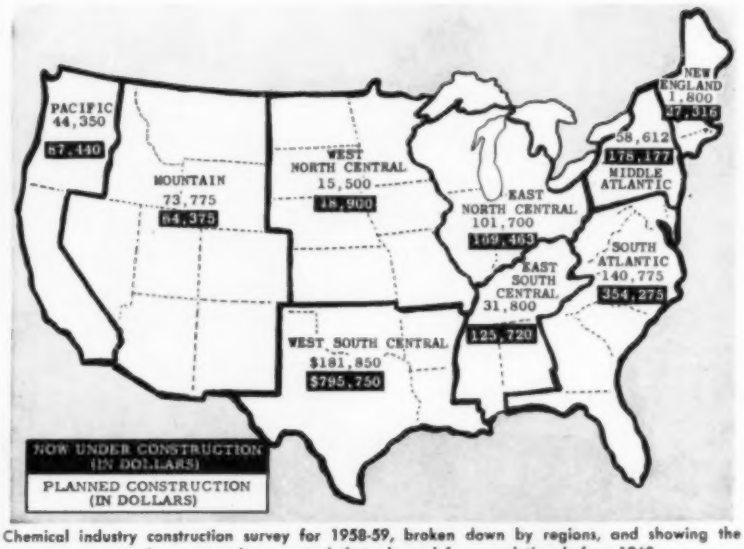
*Reg. U. S. Pat. Off.

1958-59 Chemical Construction Will Total $2.54 Billion

Annual new construction survey of the Manufacturing Chemists' Association shows that construction is up slightly over the 1957-58 period. Completed construction in 1957 totalled $1.3 billion.

Basing its estimate on the plans of companies comprising the chemical industry proper, and the chemical operations of firms identified primarily with other fields, MCA found 322 construction projects already underway, and 119 others not yet begun but scheduled for completion before 1960. It all adds up to a total of $2.54 billion.

The size of this planned growth is not unexpected. The chemical industry has long maintained the highest growth rate for major manufacturing industries. For 12 consecutive years, chemicals and allied products have averaged a total capital investment for new plant and equipment of more than $1 billion a year. Early in 1957, the industry moved into the position of the nation's third largest industry in terms of total assets—$19.6 billion.



Chemical industry construction survey for 1958-59, broken down by regions, and showing the construction now under way and that planned for completion before 1960.

Metals and Research

The emergence of the special-metals industry affected the MCA survey for the first time this year. Since the great majority of these so-called "special" metals are refined or modified with regular chemical processes by chemical-producing firms, the metals category has been broadened to include facilities being built to produce them.

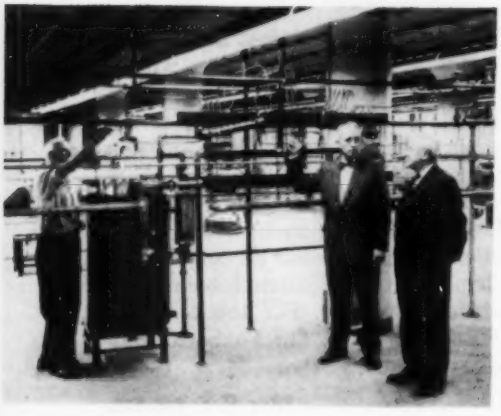
These metals include zirconium, titanium, niobium (columbium), boron, tantalum, vanadium, beryllium, uran-

(*Continued on page* 146)

MCA Chemical Industry 1957 Construction Survey. (By Category)

Category	Planned	Under Construction	Completed (Thousands $)	Totals
Fertilizer Chemicals	$ 45,575	$ 50,500	$114,800	$210,875
Inorganic Chemicals (General)	99,000	350,935	260,586	710,521
Organic Chemicals (General)	171,987	517,629	297,403	987,019
Metals	76,175	396,332	142,318	614,825
Petrochemicals	104,750	88,550	49,115	242,415
Plastics & Resins	151,500	101,820	198,120	451,440
Synthetic Rubber	18,050	145,230	134,500	297,780
Textile Fibers	.....	91,000	70,000	161,000
Laboratories	8,125	67,870	31,220	107,215
Miscellaneous	32,800	25,300	4,250	62,350
Totals	$707,962	$1,835,166	$1,302,312	$3,845,440

NEW CHEMICAL ENGINEERING BUILDING AT NEWARK COLLEGE OF ENGINEERING



The new facilities to house laboratories of the Chemical and Civil Engineering departments of Newark College of Engineering will be named Martin F. Tiernan Laboratory Building in honor of the man who made the acquisition possible.

A three-story brick building in Newark, N. J., now houses what are probably the most modern and up-to-date chemical engineering educational lab-

◀ New Unit Operations Laboratory is installed at Newark College of Engineering's new Tiernan Building. Discussing the installation are C. L. Mantell, head of the Department of Chemical Engineering (right), and G. C. Keeffe, professor of Chemical Engineering.

oratory facilities in the country. The building was the gift of Martin F. Tiernan, president of Wallace & Tiernan, Inc., Belleville, N. J.

The new building has enabled Newark College of Engineering to centralize the activities of its Chemical Engineering department, and to add much-needed facilities for research and graduate work.

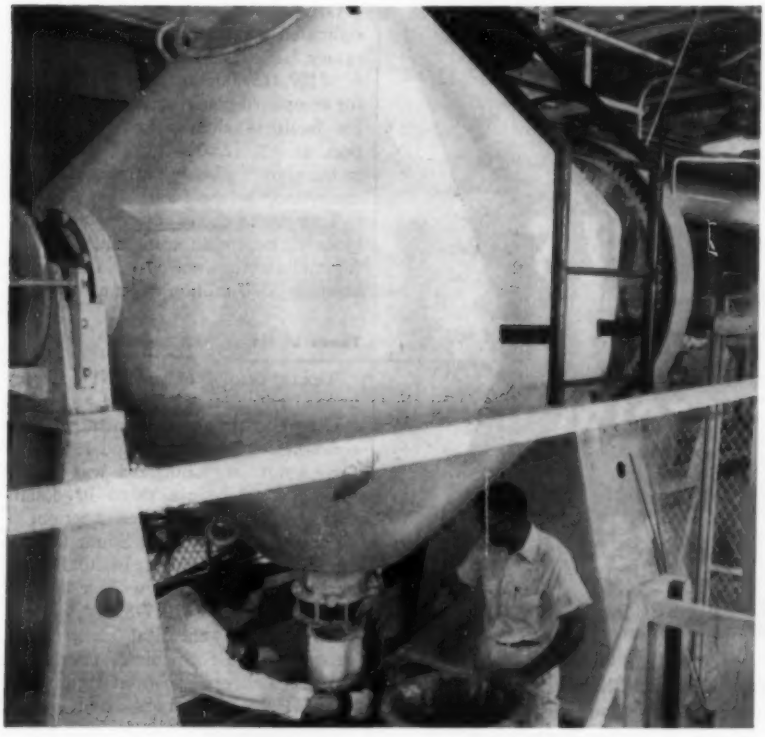
The ground floor of the new building contains the Unit Operations Laboratory, such auxiliary facilities as the machine shop, and a separate room for dust-free size reduction operations. On the first floor are the Physical Chemistry Laboratory and the Chemical Instrument Laboratory. The second floor houses the Organic Chem-

(*Continued on page* 146)

Corrosioneering News

Quick facts about the services and equipment available to help you reduce corrosion and processing costs.

Published by The Pfaudler Co., a division of Pfaudler Permutit Inc., Rochester, N.Y., U.S.A.



Now Upjohn saves 32 hours drying 2500 pounds of Orinase

Sixteen hours are all it takes for the Upjohn Company to dry and blend 2500 pounds of Orinase in the Pfaudler conical dryer-blender.

It used to take forty-eight hours to dry that much of Upjohn's oral antidiabetic in two straight vacuum dryers.

Upjohn says it also saves eight hours a week in materials handling time with the new dryer.

Since it's a pharmaceutical, the product poses a purity problem which is nullified by the noncontaminating glassed-steel construction of Pfaudler dryer-blenders.

Other companies, many handling corrosives, report similar savings, some of them cutting drying time by as much as 90%. The smooth glassed surfaces of the drying chamber are insensitive to all corrosives except hydrofluoric acid and hot alkalies above pH 12.

The Pfaudler design offers a solid, one-piece drying chamber which offers maximum strength and drying area unbroken by joints or clamps. The vacuum exhaust tube is centrally located for the most efficient vapor removal.

There's much more about the Pfaudler dryer-blender that proves its efficiency of operation over other designs . . . all of it in Data Sheet 26 which you'll find offered in the coupon.

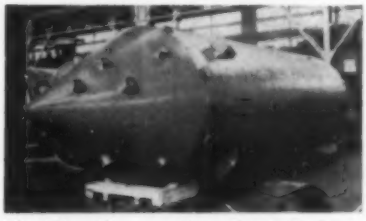
Corrosion resistance of glassed steel unimpaired by gamma radiation

No adverse effects could be detected from the exposure of Pfaudler glassed steel to 10^{10} roentgen of gamma radiation. Tests were recently completed by Pfaudler in cooperation with Oak Ridge National Laboratory and other installations.

Glassed steel is being considered for chemical processing involving nuclear energy wherever corrosive conditions are particularly severe and ease of decontamination is important.

Probable uses of glassed steel in this field include storage of acids and other materials which may or may not be radioactive, storage and disposal of radioactive wastes, and chemical processing of highly radioactive and corrosive materials.

A larger test program is now under way to follow up the preliminary results and to determine even more conclusively the effect of radiation on glassed metals.



"Is Pfaudler making Sputniks?"—This was an oft heard question recently from visitors to our Rochester plant. What they saw was this unusual new cone bottom reactor we fabricated and glassed for a leading chemical producer. All those nozzle openings on the conical surface made glassing a little "touchy," so it took us a little longer than with standard models. The vessel is 388 inches long with a 138-inch OD, and will be used for storing and purging polymer chips at 160°F. An internal column does the purging with an inert gas.

Why do we show it here? To suggest that we can put the corrosion resistance of Pfaudler glass to work on more than conventional reactors, storage tanks, columns, etc.

THE PFAUDLER CO.
a division of PFAUDLER PERMUTIT INC.
Dept. CEP-28, Rochester 3, N.Y.

Please send information on: ☐ Conical Dryer-Blenders ☐ Pfaudler Buyer's Guide.

Name.....

Title.....

Company.....

Address.....

City.....Zone.....State.....

Metallurgists, Nuclear Engineers: Michigan Chemical can now supply ingots of Gadolinium, Yttrium, Dysprosium, and Erbium metals in substantial poundages for use in nuclear control rod, shielding, or alloy system applications.

METAL	MELTING POINT °C	BOILING POINT* °K	ATOMIC RADIUS	DENSITY GRAMS/CUBIC CENTIMETER	THERMAL-NEUTRON CROSS-SECTION (BARNS)
Y	1552	3300	1.81	4.47	1.38
Gd	1350	3000	1.8	7.87	46,000
Dy	1400	2600	1.77	8.56	1,100
Er	1500-1550	2900	1.75	9.06	166

*Estimated

Discuss with us availability and prices on commercial quantities. This will permit you to analyze the economic and technological advantages of rare earth metals versus other metals — for example, Gadolinium versus Hafnium in nuclear control. This will also permit the evaluation of special alloy systems such as Gadolinium in stainless steel.

RE-58-1

RARE EARTHS AND THORIUM DIVISION

MICHIGAN CHEMICAL CORPORATION

578 North Bankson Street, Saint Louis, Michigan

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SAMARIUM — EUROPIUM — GADOLINIUM — TERBIUM — DYSPROSIUM — HOLMIUM — ERBIUM — THULIUM — YTTERBIUM — LUTETIUM — YTTRIUM

INSTITUTIONAL NEWS

CHEMICAL CONSTRUCTION

(*Continued from page* 144)

ium, alumina, and mercury. Excluded are such metals as copper, magnesium, aluminum, lead, and zinc.

Of special significance today is the estimated investment in research laboratory facilities. The three-year figure of $107,215,000 includes $31,220,000 for completed construction, $67,870,000 for facilities already under construction, and $8,125,000 for facilities still in the planning stage but scheduled for completion before 1960.

Today, the chemical industry's total research expenditure, including operating and maintenance costs, is estimated at some $500 million a year.

Texas Leads

Texas, second only to New Jersey in total chemical production, again had the highest total investment in new construction over the period 1957-59—$864.5 million. Louisiana was second and West Virginia third in dollar-value of new chemical construction.

Regionally, the West South Central States are far ahead in total new chemical construction with a total of $1,422,077,000 for 1957-59.

In types of chemical construction, general organic chemicals maintained the number one position again this year. Behind organics came general inorganics, metals, plastics and resins, synthetic rubber, petrochemicals, fertilizer chemicals, textile fibers, and laboratories.

Publication of Statistical Summary No. 2, second supplement to the fourth edition of the Chemical Statistics Handbook, has been announced by the Manufacturing Chemists' Association. The basic reference was published in 1955, containing a variety of information and statistics relating to the chemical and allied products industry for the period 1950-53, with partial data for the first half of 1954. The current supplement carries through the first six months of 1957. □

NEWARK COLLEGE

(*Continued from page* 144)

istry Laboratories, graduate and staff research laboratories, classrooms, and offices. The third floor includes several specialized laboratories for instrumentation, electrochemical engineering, adsorption, organic research, and small scale investigation.

from the first large-scale $NaBH_4$ *plant comes a basic ingredient for*

ZIP FUELS

Badger constructs new Metal Hydrides plant from site clearance to start-up. This new plant is among the first to produce $NaBH_4$, an important ingredient of "exotic fuels" for trans-sonic devices, on a large scale. From site clearance to initial start-up, Badger handled the complete equipment engineering and construction for the project.

While the characteristics of sodium borohydride make it fine for high performance fuels, its production creates real problems in equipment and plant design. How well did Badger meet and solve these problems?

Officials and engineers at Metal Hydrides have said they were impressed by the proven ability of Badger personnel and by the intelligent approach that was brought to MHI's problem. In addition, Badger was complimented for its willingness to undertake the project on a "crash" schedule. Metal Hydrides' judgment proved sound when Badger delivered the plant on schedule in spite of delays due to the steel strike.

Each year more and more leading firms with unusual and pioneering engineering projects choose Badger. The ability and experience that lead so many to the same choice can pay off on your projects, too. Why not inquire?

The Badger Key Man

FROM INITIAL NEGOTIATIONS TO "ON STREAM" YOU DEAL WITH A BADGER PRINCIPAL. *Badger Engineering Projects are group efforts headed by a Key Man. More than just a sales engineer, he is always a Badger principal — always the Key Man in the execution of the project.*

By channeling project liaison, coordination and administration through a widely experienced company principal, you find many policy level decisions can be made on the spot. Investigate what Key Man Policy can mean to the projects you are planning.

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Aerial view of Metal Hydrides' new Sodium Borohydride Plant at Danvers, Massachusetts, as it looked while under construction. The plant process involved the preparation of sodium borohydride using sodium and boric acid as raw materials.

selling

A TECHNICAL PROGRAM

to the public

Charles L. Black | Hill and Knowlton, Inc., New York, New York

Great concern is being shown today over the problem of "bridging the gap" between the engineer and scientist and the general public. The major stumbling block—communication!

Advances in science have been so rapid, and scientific endeavor has become so specialized, that engineers, chemists, biologists, physicists, and geologists even have trouble communicating with each other. How much more difficult it is to communicate technical information to the layman, to a company's customers, and even to its stockholders, directors and management!

Yet it is generally recognized that corporate technical programs should be explained to the public. Public understanding of the research and technical capabilities of any company is an important factor in enhancing its reputation—with investors, with the communities in which the company operates, with government, and with consumers.

To the ultimate consumer, corporate technical programs can have direct and personal meaning in terms of his pocketbook, his security, or his present or future welfare. In the minds of the public, a company's future is closely related to the quality and scope of its research efforts and its technical programs.

The methods and means of selling a technical program must, of course, vary with the audience. There is no effective way of selling (or, for that matter, of even defining) the "general public." It's like the problem of describing the "average" man—that nonexistent individual who, having the characteristics of all, has the characteristics of none.

As is true with every communications job, the first essential in selling a technical program is to focus on the particular group we want to reach. What is our audience? What are this audience's interests? What is it that we want to communicate?

We would not talk about a technical program to the American Institute of Chemical Engineers in the same terms we would use for the Carbondale, Illinois, Rotary Club. We would tell a different story to the ultimate customer than we would want to tell to the business community. Each group has its own interests; each must be reached in terms of its own knowledge and its own needs.

For most purposes, a company's technical program should be sold to at least three general groups:

There are our *fellow scientists, engineers and technicians.*

There is the *business community*—the people outside our own field, including management of our own and other companies, investors, stockholders, suppliers, bankers, and others.

And there is the *ultimate customer*, the ultimate beneficiary of research or technical activities, the person who will gain from the product, the services or the techniques on which we are working.

We should examine some of the means that can be used, and have been used in the past, to keep these broad groups informed of progress in various technical fields.

The Scientific Community

Within the scientific community, the means and the form of communication have become fairly well standardized, and the task is somewhat less difficult because communications are conducted in the vocabulary of science. With these groups, the scientist or engineer deals ordinarily with individuals who speak more-or-less the same language, who understand mathematical communication, the chemical or algebraic equation, blueprints, and data sheets.

The so-called sales job itself is also simplified within a select scientific circle. There is no need for popular interpretation: we talk about results, in detail; we examine, in the exact language of the field, what the work means in terms of our own and of others' scientific work; we can explore the meaning of our own activities in relation to scientific knowledge in general.

The communications task is conducted in technical journals, in technical reports, in meetings of technical societies such as the A.I.Ch.E.

But the picture is far different when we go farther afield, when we face the problem of selling a technical program to the business community or to the ultimate customer. That is where it becomes necessary to interpret and translate, and to use communications tools and techniques which have been refined by certain specialists over the past few years.

The Business Community

Take the problem of selling the technical program to the business community. This audience is drawn from many different occupations and fields. It may range from top management to accountants, from sales executives to labor relations experts, from stockholders to subcontractors and suppliers.

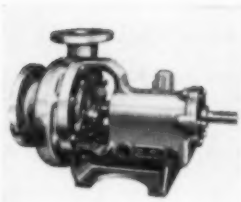
With them, in most cases, it is necessary to explain a program in terms of its practical or commercial significance. What new products or services will result? Will this research and development result in new applications that could mean new markets? Will it reduce costs? Will it increase production?

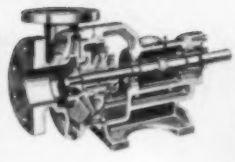
An examination of business and trade publications can readily show the extent to which corporations today are trying to sell their technical programs to the important segments of the business community. In a random check made recently of the advertising in a typical financial publication, it was discovered that of 16 full-page advertisements placed by some of the country's leading manufacturing companies, *more than half* were aimed at selling the reader on the companies' leadership in research and development.

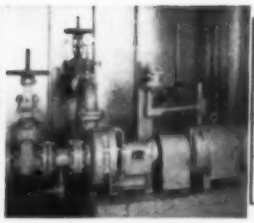
In this one issue, for example:

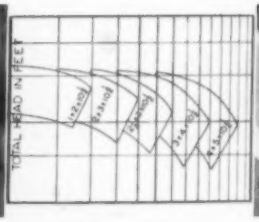
- The Radio Corporation of America cited the development of Bizmac, one of its electronic "brains," and told of the job Bizmac is doing for American business.
- Allegheny Ludlum pointed out that

(*Continued on page* 150)









BECAUSE... PEERLESS CHEMICAL PUMPS:

MEET critical standards of construction, you benefit from longer pump life, less maintenance, and sharply reduced incidence of system shut down caused by pump failure. Top quality Peerless construction means a dependable, rugged pumping unit you can count on to stay on the job for years longer.

PROVIDE proved operating history, you benefit from the knowledge that you're not buying a pump in the dark. Analysis by Peerless of customer pump operating records allows continuous product improvement. Correlation of this data provides Peerless with answers to nearly all field pumping problems.

OFFER optimum performance range, you benefit from the economical performance only the exact pump for the job can give you. The Peerless process pump line of over 78 models, sizes and frames, plus thousands of combinations, assures you of pinpoint pump selection that effects direct savings in cost.

EMBODY benefits of research in all areas of design, construction, and application. Typical of the many considerations in the design and manufacture of a Peerless pump is the ascertaining of effects of radial loads. **An interesting 8 page booklet discussing this phase of pump design is available to you upon request.**

Engineers and Pump buyers say:

NOW WE CAN BE SURE!

...buy and apply PEERLESS PUMPS

Putting Ideas to Work

fmc

FOOD MACHINERY AND CHEMICAL CORPORATION

Peerless Pump Division

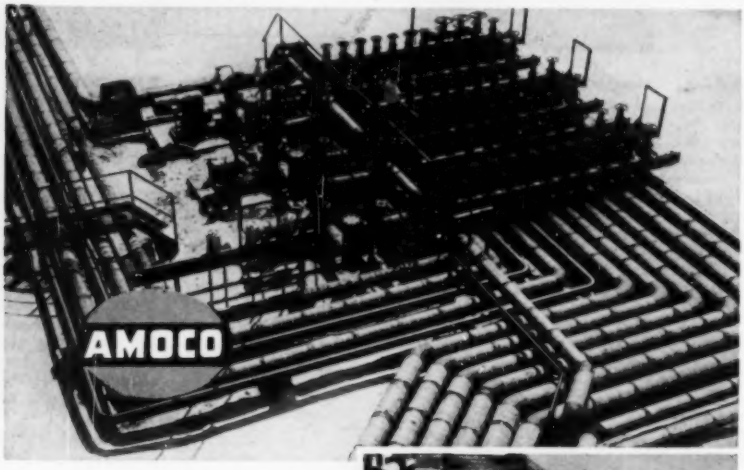
Plants: LOS ANGELES 31, CALIFORNIA and INDIANAPOLIS 8, INDIANA

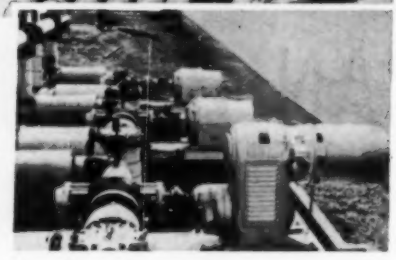
Offices: New York; Atlanta; St. Louis; Phoenix; San Francisco; Chicago; Fresno; Los Angeles; Plainview and Lubbock, Texas; Albuquerque.

Distributors in Principal Cities. Consult your telephone directory.

AMERICAN OIL COMPANY equips two east coast Asphalt terminals with

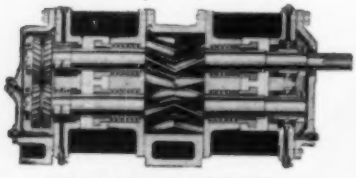
Sier-Bath GEAREX® PUMPS



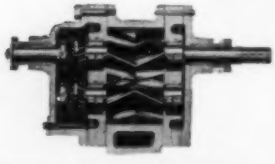


• Above is a typical asphalt terminal manifold using three "Gearex" Pumps. Each pump is designed to deliver 350 gpm. of asphalt with 600-3,000 SSU at 300 to 130° F., discharging at 50 psig. with a 16" Hg. maximum suction lift. The big feature is the external gear and bearing design which protects vital pump parts against damage when handling hot asphalts, crudes, cutbacks and other viscous, non-lubricating materials.

***Sier-Bath* "Gearex" Pumps**



EXTERNAL GEAR & BEARING TYPE
for non-lubricating liquids



INTERNAL GEAR & BEARING TYPE
for lubricating liquids

Sier-Bath "Gearex" Pumps provide positive displacement, pulseless flow . . . quiet, vibrationless operation. Direct-connected up to 1800 RPM, they require no reduction gears. For sustained high volumetric efficiency and long life there is no rotor-to-rotor or rotor-to-casing contact. Low pressure on stuffing boxes provides easy servicing.

Horizontal or vertical models to handle 32 to 500,000 SSU, 1 to 550 GPM at 250 PSI for viscous liquids, 50 PSI for water. Corrosion-resistant alloys, steam-jacketed bodies, water-cooled bearings, other adaptations to meet individual needs. Call your local Sier-Bath Pump Representative . . . send for Bulletin G-2. *Sier-Bath Gear & Pump Co., Inc., 9272 Hudson Blvd., North Bergen, N. J.*

Sier-Bath ROTARY PUMPS

Screw Pumps — Gearex® Pumps — Hydrex® Pumps

50th Anniversary — Mfrs. of Precision Gears, Rotary Pumps, Flexible Gear Couplings — Member A.G.M.A.

SELLING A TECHNICAL PROGRAM

(*Continued from page* 148)

one-sixth of the company's 1956 sales—and an even greater percentage of the company's profits—came from products it didn't even make five years ago.

• International Telephone & Telegraph talked about its "creative engineering" and described the benefits of a closed circuit television system it has developed.

• American Viscose Corporation expressed the belief that "a more abundant tomorrow for everyone can be given a head start in our laboratories today."

These advertisements were not technical messages. They were aimed at the investing public. But they were each designed to make one point clear: the importance of the technical activities undertaken by these firms.

Advertising is, of course, only one of the many communications tools used in an active and coordinated program of this type.

In most of the others, the scientist or engineer should participate at least on a consultative, and frequently on an active, basis. When publicity is developed on programs for use in business and trade publications, much depends on the ability to translate the meaning of scientific activities in terms that businessmen will understand. When technical programs produce results that have popular significance, engineers need to be able to interpret these results to the company's public relations staff, who in most cases will handle the actual communications job.

Many corporations have gained in public understanding by conducting information and orientation tours of research and technical facilities. Other companies have found that research and technical personnel can play an important role in selling the company and its activities by speaking appearances before key groups, or by participation in business and trade meetings.

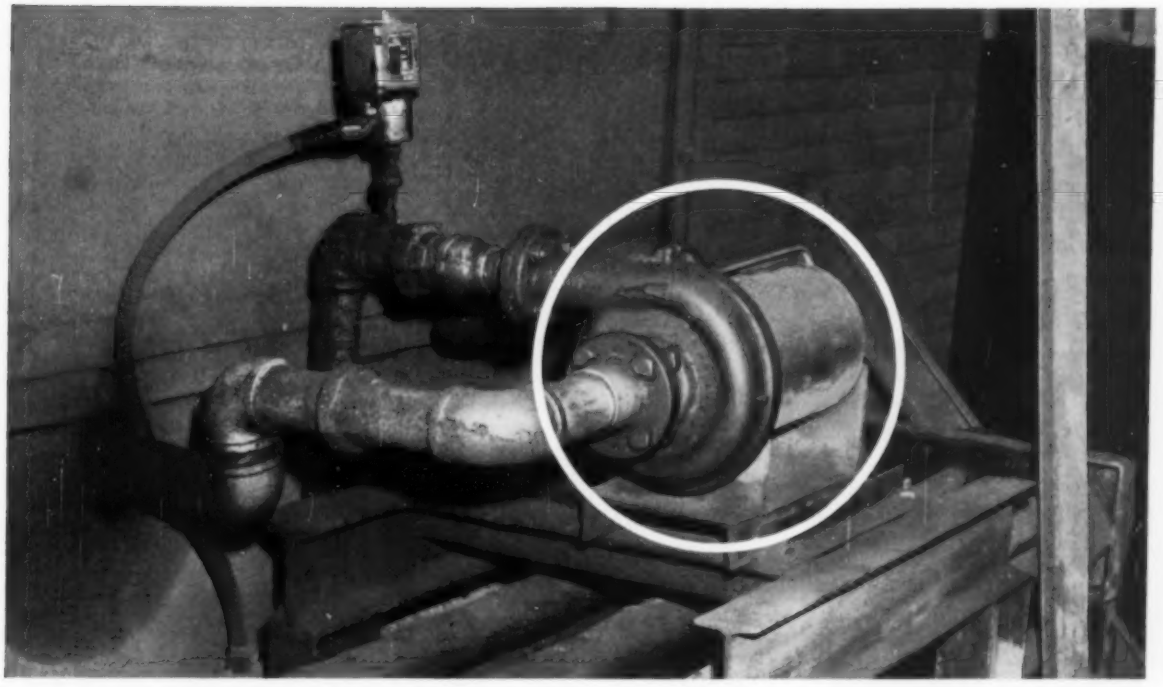
The Consumer Community

The engineer is equally important in assuring the effectiveness of the broader job of communicating with the ultimate customer or beneficiary of the technical program.

Here are people who, most of them lacking technical backgrounds, must be sold in everyday, easily-understood language. In reaching these groups, it is necessary to relate the technical program to such results as greater durability of present products, increased comfort, greater performance, or better health.

The sales message to the ultimate consumer

(*Continued on page* 152)



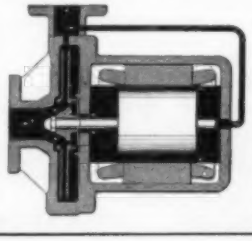
Chempump gives leak-proof service

handling transformer oil at ultra modern Ohio foundry

This *Chempump* circulates oil through the heat exchanger of an electric furnace power transformer. It was installed at one of the world's most modern foundries in September, 1955. *It has required no maintenance to date.*

Unlike conventional centrifugal pumps, *Chempump* can't possibly leak, no matter what fluid is being pumped. It's a totally enclosed unit—without seals, stuffing box or packing. No external lubrication is needed, for bearings are constantly lubricated by the pumped fluid itself.

Chempump's long-term dependability cuts process pumping costs everywhere. Learn how you can gain its many advantages in your own fluid handling application. Write for specific information to Chempump Corporation, 1300 East Mermaid Lane, Philadelphia 18, Pa. Engineering representatives in over 30 principal cities in the United States and Canada.



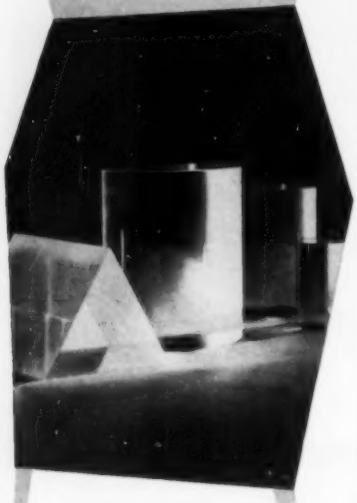
Chempump combines pump and motor in a single, leak-proof unit. No shaft sealing device required.

U.L. approved. Available in a wide choice of materials and head-capacity ranges for handling fluids at temperatures to 1000 F. and pressures to 5000 psi.

Chempump

First in the field...process proved

CRYSTALS...
our only business



- SCINTEX BRAND Plastic Phosphor Scintillators
- Anthracene & Stilbene Single Scintillation Crystals
- Alpha, Beta, and Fast Neutron Scintillation Detectors
- Sodium Iodide (TL) Crystals
- Lithium Iodide (EU) Crystals
- Cesium Iodide (TL) Crystals
- Optical Crystals
- Special Crystals Grown To Order

SCINTEX BRAND PLASTIC PHOSPHORS are used in exacting research applications as well as in standard instrumentation where stable, long-life performance characteristics are demanded at an economical cost.

We unconditionally guarantee the performance, workmanship and materials of our SCINTEX BRAND Plastic Phosphors for one year in normal usage.

Write to Dept P-2 for technical and price information

CRYSTALS, *Inc.*
123 Woodland Avenue
Westwood, N. J.

a subsidiary of Isotopes, Inc.

SELLING A TECHNICAL PROGRAM

(*Continued from page* 150)

must keep in mind that no laboratory effort means a thing except in terms of people, their aspirations, their needs, their lives. Successfully concluded, a technical program results in the kind of things that people want, and will buy.

Too many of the attempts to sell technical programs fall short in the area of communication with the ultimate customer. Too frequently, the emphasis is on the *means* to the end, rather than the end itself.

In directing attention to the easiest, simplest, most accurate way of telling the story of a technical program to the public in layman's terms, engineers can be of invaluable help to the overall communications programs of their companies.

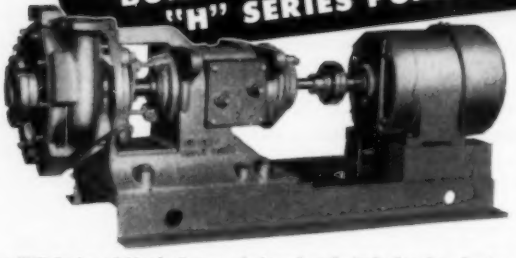
While the communications job itself may not be the engineer's, he is the key to it. The accuracy of the story, the benefits to the company, may well rest on his ability to translate the results of his efforts into terms of the ultimate benefits to be derived from them.

While we have not yet reached that point in human affairs, there is little doubt that the scientist and technologist in business today must play a growing part in interpreting and selling his technical activities. To the impressive technological contributions he has made to industry, he must add proficiency in communications—in relating the technological activities of industry today to the needs of our future economy and our national security.

Presented at the Chicago Annual Meeting of A.I.Ch.E., December, 1957.

Federal tax deductions up to 20 per cent of gross income are permissible for taxpayers who donate their services gratuitously to organizations such as the A.I.Ch.E. Unreimbursed traveling expenses, including the cost of meals and lodging while away from home in connection with the affairs of the association and at its direction, may be deducted in the computation of net income. The only limitation is that the total amount of such *gifts* may not exceed 20 per cent of the donor's gross income in any one year, and that such expenses must be included with other gifts in computing the 20 per cent limitation. □

"INTESTINAL FORTITUDE" BUILT INTO NEW NAGLE "H" SERIES PUMPS

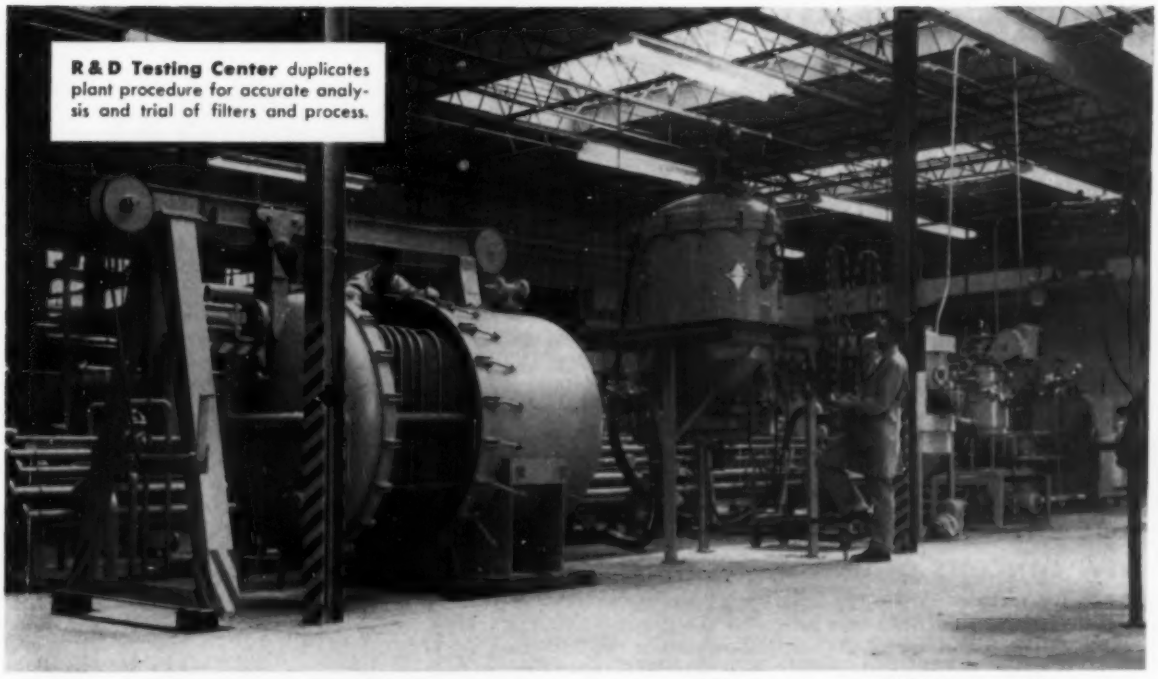


The new "H" Series of Nagle Pumps, designed exclusively for the abusive pumping jobs of industry, is simplicity itself. Three types of water ends available to meet specific conditions, type "HF", "HC" and "HR" (shown). Various alloys used for water-end members depending upon corrosive, abrasive or high temperature conditions involved. Water-end can be rotated to any one of four discharge positions. Slippage seal adjustment takes only moments using a common wrench. Packing gland is readily accessible. Radial adjustment of shaft to insure concentricity through stuffing box is a matter of seconds. Various types of impellers available. Impellers readily accessible. Oil or grease lubrication is optional. Sizes from 1" to 10". Heads up to 250' or more. Capacities to 4,000 G.P.M. A "must" for those tough applications where ordinary pumps fail. Send for Bulletin "H"

NAGLE PUMPS

NAGLE PUMPS, INC.
1255 CENTER AVE., CHICAGO HEIGHTS, ILL.

PUMPS FOR ABRASIVE AND CORROSIVE APPLICATIONS



R & D Testing Center duplicates plant procedure for accurate analysis and trial of filters and process.

New Research Center analyzes filtration under full-scale process conditions

Industrial's Research and Development Division helps you select filters and study processes without disturbing production in your own plant.

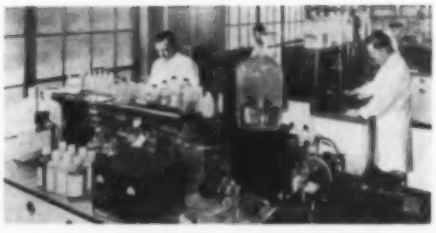
Maximum efficiency in filtration can only be gained by **examining filters and the process in actual operation.**

To do this, Industrial can place at your disposal $250,000 worth of equipment and a staff of chemists, engineers and physicists experienced in the problems of liquid-solid separation.

The Testing Center includes all types of pressure filters, batch and slurry tanks, heating and cooling systems, chemical addition systems, and various pumps . . . all interconnected with an ingenious valve and piping system. **Any conceivable process condition can be duplicated at Industrial.** Fluids can be routed from batch or slurry tanks to any filter to test its effectiveness, operating efficiency, and make rapid comparisons of filter types. The process itself can be studied thoroughly and **comparative data on variations is obtained in minutes** instead of days of costly experimentation in your plant.

Industrial builds filters for your processes with the same scientific approach and practical engineering skills that produced this advanced analytical center.

Talking to an Industrial field engineer will put you in touch with the most capable staff and research facilities available today. Bring your filtration problems to Industrial. We will be glad to make analyses and recommendations.



R & D Chemical Laboratory checks and maintains quality control of influent and provides precise analyses of effluent during testing and research operations.

R & D Physical Lab. . . . analyzes densities, viscosities and other physical properties of process fluids . . enables engineers to check filters and make pilot runs under simulated conditions.

INDUSTRIAL

INDUSTRIAL FILTER & PUMP MFG. CO.
5910 OGDEN AVENUE • CHICAGO 50, ILLINOIS

CHICAGO DISCUSSION SESSIONS

What do chemical engineers attending Institute meetings think about issues of major importance to their profession? At the recent Chicago Annual Meeting of A.I.Ch.E., several informal, off-the-record discussion sessions were held. What in general, was said is reported on herewith by the session moderators.

PRODUCTIVITY IN R & D: *John S. Wilson*, Heidrick and Struggles, Chicago, Ill., Session Moderator

Productivity of research and development people can be increased by association with other departments. This association *must* be carried out and, furthermore, it can be planned. The project coordination system is one way to plan this association. A good responsible project coordinator must correlate the activities of research and development people with the sales and production people and all other departments of the company. A coordinator can work with a checklist of all the aspects of the project requiring attention. As time goes on during the project life, more and more of the points on the checklist will be clarified. With these answers obtained, the proper decisions can best be made as to the future course of the project.

One of the important aspects of productivity in research and development is the decision on when to start and stop a project. The evaluation must keep in step with the changing situation, and every facet of a company's business affects these decisions. Projects should be re-evaluated critically whenever a new phase is anticipated (such as a change from bench scale to pilot plant scale), when original estimates of time and/or money have been used up, or when a change occurs in the industry that might affect the market for the product. The decision as to whether to go ahead should be made at a top level, with consultation from other departments.

Most scientists look upon statistical analysis as only an alternative method and feel that there are other ways of

(*Continued on page* 156)

NEW CONCEPTS OF UNIT OPERATIONS: *D. L. Katz*, University of Michigan, Session Moderator

Plans for revisions in the curricula at their respective schools were presented by professors R. R. White, R. H. Wilhelm, and W. R. Marshall, Jr., at the Chicago discussion session in which they participated. All have introduced the more generalized concepts of rate processes for momentum, heat, and mass transfer and no longer give graduate courses of the conventional variety in Unit Operations. The undergraduate programs are under study, and either have been changed or will be shifted away from the conventional approach. The reasons for the changes are that much more is known about application of the general principles than was available when the Unit Operations were initially developed. The pressure of ever-expanding knowledge in the field leads to a retreat to a more general and fundamental classification. A number of those present indicated that their schools were undergoing a transition and development in the area of Unit Operations.

Discussion covered a wide range of topics. The more pertinent and germane were as follows:

1) The question was raised as to whether the more generalized approach would give the student the ability to solve engineering problems. An industry representative stated that engineering problems solved by use of the conventional Unit Operations approach were in the "routine" area and that they were using chemical engineers to solve complex problems in the development of the overall process.

(*Continued on page* 158)

COST CONTROL: *Frank R. Fisher*, Sinclair Research, Inc., New York, N. Y., Session Moderator

Cost controls must have goals or standards in order to be effective. Each of the Cost Control Symposium speakers had emphasized some type of yardstick against which cost performance was measured. A variety of types of standards had been discussed in some detail.

R. Gutoff, who had presented one of the papers, again pointed out that "cost control" is a term which should be applied to keep costs within acceptable limits, and that a second term, "cost reduction," might be more descriptive of the real purpose of cost programs. New methods of operation, more efficient utilization of personnel, reduced raw material costs, and increased utilization of equipment all lead to cost reduction. Continued surveillance to keep operating costs from rising should be classified as cost control. When a cost reduction takes place, new cost control standards should be established.

J. W. Davie, another author, discussed several uses of electronic computers for controlling and reducing costs. Basically, these computers provide plant management with more complete and more accurate data and reveal areas where cost reductions can be made. Management also gets a detailed breakdown of operating costs more rapidly, thus promoting more effective cost control.

There was discussion of the advantages and disadvantages of a formal cost control group within an operating organization. W. J. Shelley, who had also presented a cost control paper,

(*Continued on page* 160)

PROJECT EVALUATION: *Russell G. Dressler*, Consultant, San Antonio, Texas, Session Moderator

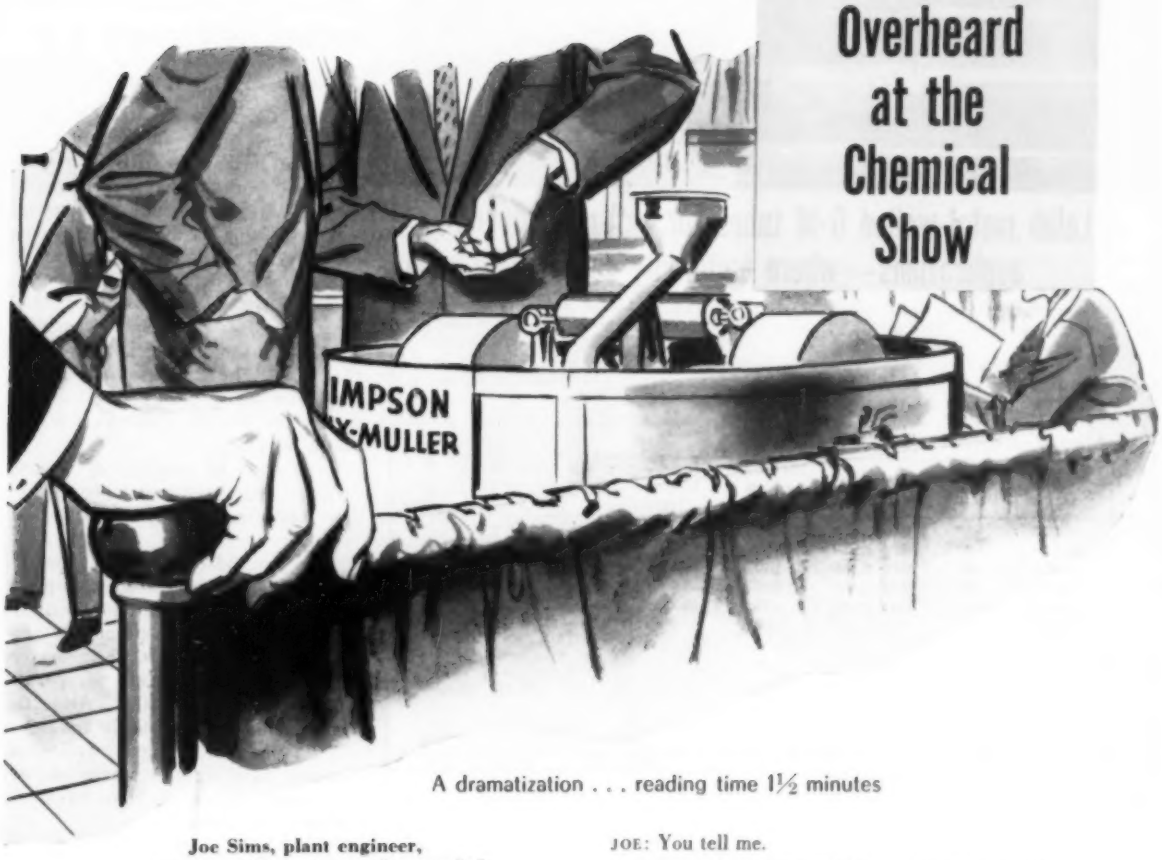
The first question considered in the discussion was: "Can we put the evaluation of a project and its possible returns on a mathematical basis by applying known values and probability factors?" Expressed differently, the question might be: "Can we reduce the outlook on a project to the probability of a roulette wheel?" In answer, most of the engineers thought this was difficult to accomplish because of the uncertainties of markets, of research results, etc.

Another question concerned the number of steps necessary in the development of a project. Is a semi-works plant needed in addition to the pilot plant? It was pointed out that in most cases the semi-works plant serves principally to furnish material in quantities for market development; otherwise, for process development, only portions of the process might require testing on this scale.

Inquiry was made as to who in the various companies was responsible for project evaluation. Is it under research, engineering, or a specialized group? Some companies have specialists to follow and guide a project through successive stages, so that continuity is assured. Most stated that the research chemist severs from the project development when it enters the pilot plant phase. The research chemist, however, in most cases continues special studies and solves new problems concerned as they arise in the subsequent development work on the project. The organization and procedure for carrying through from

(*Continued on page* 162)

Overheard at the Chemical Show



A dramatization . . . reading time 1½ minutes

Joe Sims, plant engineer, wasn't as idly curious as he sounded when I overheard this conversation at a recent trade show:

JOE: What're you grinding up there?

Answer: It's sawdust—but we don't *grind anything* here. We're "mulling" *(pouring the contents of an envelope into the mixer)*. Watch this . . . *(pause)*.

JOE: That was fast!

Answer: The Mix-Muller dispersed that green dye throughout the sawdust in less than 2 minutes. Call the dye a binder or a reagent and you can better understand why a smearing or rubbing action is essential where dry materials must be mixed with relatively small quantities of liquids, semi solids or amorphous solids.

JOE: You tell me.

Answer: OK, if I *stirred* the dye in with a stick or paddle we would have a pepper and salt effect. The elements would be *next* to each other but not blended. It takes the folding of the Mix-Muller plow action, combined with a rubbing, kneading, muller action to give you an intimate, *reacted* if you will, blend of materials. Apply that to a product that must be extruded, cast, briquetted or wetted to a slurry and you can see why we say we sell *controlled uniformity* here.

JOE: *(Later and aside to me)* You know, asking those Mix-Muller people what mulling is, is like putting a nickle in a juke box. They've got a whale of a story on mixing dry solids—I *know* . . . we've got five of them in our plant. I reconfirm this story every time I come to this show.

If *you* mix, and it's dry but not a powder, wet but not a liquid there's a whale of a story in this book for you. Write for "Mulling for the Chemical and Process Industry" today!

SIMPSON *MIX-MULLER*® DIVISION

NATIONAL ENGINEERING CO., 652 Machinery Hall Bldg., Chicago 6, Ill.
(Not Inc.)

Lelab metal-walled G-M tubes for anti-coincidence applications—where uniformity counts!

Except for a glass bead insulator, Lelab Counter Tubes are constructed entirely of metal. The metal cylinder is used both as the envelope and the cathode.

The restriction of all component parts within the diameter of the tube permits close stacking. Each counter is custom-built, filled, and tested in order to insure stability and uniformity.

Some current production types are listed below; other designs can be obtained on special order.

Type	Active Length	Starting Voltage	Plateau Length (Volts)	Plateau Slope (%/100 v.)	Diameter and thickness of Cathode
B5A10	3"	870 ± 30	>200	<5%	1" x .020" Brass
B5A5	3"	870 ± 30	150	<5%	½" x .020" Brass
B12A5	10"	870 ± 30	150	<5%	½" x .020" Brass
B18A10	16"	900 ± 30	>200	<5%	1" x .020" Brass
B26A20	24"	1000 ± 35	200	<10%	2" x .031" Brass
*C6E10	4"	970 ± 35	300	<5%	1" x .031" Copper

NOTE: Overall sizes are approx. 2¾" greater than active length. The length of the metal cylinder is approximately 2" greater than the active length in each case. Length of exhaust tube, not included in above chart, will be ¾" normally except where longer tubulation is requested. * These tubes employ ether or ethylene as the quenching vapor and will operate at lower temperatures than the alcohol type.

Write for complete information

H. W. LEIGHTON LABORATORIES, York & Sunset Lane, Hatboro, Pa.

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CENTER FOR HIGH PURITY FUSED QUARTZ

AMERSIL is the primary source for fused quartz and silica of the highest possible purity. Our fabricated labora... ...uction equip-ment is used ... ...cal purity is ...drical con-...ing (up to ...y. Amersil ...ssist in de-...uirements.

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- HOMO
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HILLSIDE 5, NEW JERSEY

...ED SILICA ...QUARTZ

685 RAMS

...HARD INDUSTRIES

★ ★

PRODUCTIVITY IN R & D

(*Continued from page* 154)

reaching the answer that are just as good. This is not always true—the statistical method is often the only way to solve the problem in a feasible manner. To use the statistical method requires setting up the right questions for research. The research must be planned based upon the correct relationships of the variables. The statistical method is probably best applied by professional statisticians working closely with the scientists on the problem, although scientists often can themselves develop aptitudes for statistical method.

Deterrents to productivity among research and development people are: poor facilities, routine administrative or supervisory duties, and salary inequities (or belief that salary inequities exist). Creating an atmosphere of professionalism helps productivity. This can be done by promoting professional meetings and bringing in consultants and lecturers to speak—formally and informally. Also, the men should be exposed to the full range of the problem at hand. Individual personal handling of research and development personnel helps create a professional atmosphere.

Productivity can be increased by setting up good communications and by having appraisals made by technically competent people. The proper incentives in promotions, salary increases and other recognition, and making people know exactly what is expected, also contribute to greater productivity. The company's policies must be made clear to research and development people if their efforts are to be productive.

Productivity can be predicted within wide limits. One company's policy is to hire very young men and to promote from within. Therefore, it pays them to attempt to predict a young man's productivity. They do this by a system of pre-employment tests and interviews.

The following factors are important in rating the future productivity of a man: health, emotional control, intelligence, word skill, character training, fit with people already in the company, stability of interests, potential career level, originality of thinking. These factors are evaluated in each prospective employee in interviews, in the application blank, and tests which rate the I.Q., word skill, facility with mathematics, and relation of scientific

(*Continued on page* 158)

When is a bargain not a bargain?

If your supplier neglects any one of nine important steps in the production of stainless steel plate his product may not be a bargain for you.

The wise buyer of stainless steel plate and plate products insists upon the solid service and sound methods of production that are identified with G. O. Carlson, Inc.

- Composition of each melt rigidly controlled to come well within the specification; with carbon always reported to the third decimal.
- Adequate trimming of both the hot top and butt end after the slab is rolled to guarantee sound material.
- Removal of all surface imperfections before the slab is rolled into plate.
- Annealing and rapid cooling of every chromium-nickel plate to produce material with the greatest corrosion resistance.
- Careful in-plant handling to minimize blemishes and imperfections.
- Close inspection of finished plates and the removal of minute flaws.
- Shearing, sawing, abrasive and flame cutting held to close tolerances to minimize costly machining and fitting in your plant.
- Rigid inspection of work throughout entire production cycle.
- Prompt, on-time delivery to maintain your production schedules.

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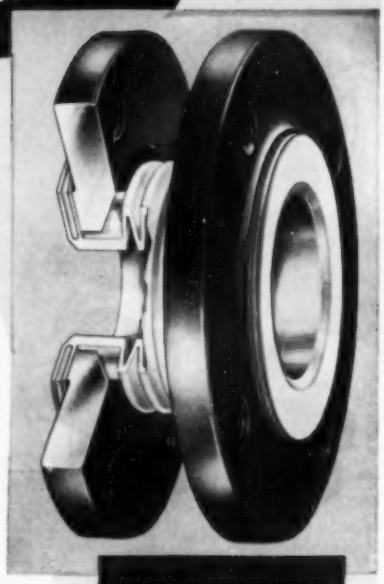
Here's The Plain Truth About CHEMLON® Flexible Pipe Connectors

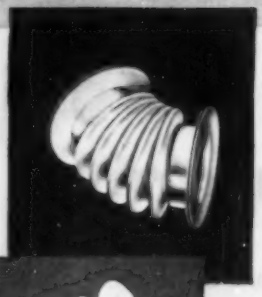
*"John Crane"** *fabricated from DuPont Teflon*



When it is a question of handling corrosive fluids in processing or hydraulic equipment —Chemlon Connectors best meet the need. They are fabricated from the most chemically resistant material available, DuPont Teflon. The most destructive acids, corrosives and solvents have no deteriorating affect*

Other important advantages are their long service-life, extreme flexing ability and wide temperature range from −65°F. to +350°F.

Chemlon flexible pipe connectors offer a definite plus value construction-wise. 1) They are made from Teflon specially fabricated for high and uniform density. 2) An exclusive manufacturing method assures uniform wall thickness throughout the convoluted area. 3) They are formed at full free length to reduce residual and working strain to an absolute minimum.

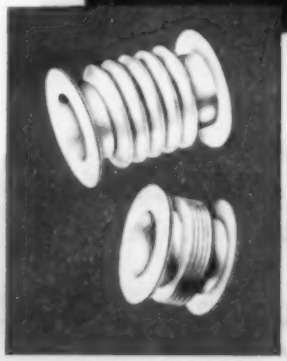


Vibration and Misalignment

—severest vibration and misalignment conditions, such as pump to agitator or mixer to tank, will cause little deterioration or fatigue. Also, the Chemlon Flexible Pipe Connector serves as an acoustical as well as a mechanical dampener.

Expansion and Contraction

—continuous flexing over a wide range of temperature conditions has little affect on Chemlon Flexible Pipe Connectors.



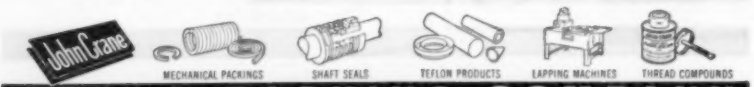
CUSTOM FABRICATED

Chemlon Flexible Pipe Connectors can be custom machined or molded to meet any requirement from one convolution up... any shape or size . . . open or closed end. They handle pressures to 75 psi.

•

Request full information. Crane Packing Co., 6443 Oakton St., Morton Grove, Ill., (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

**Except fluorine and molten alkali metals.*



CRANE PACKING COMPANY

DISCUSSION SESSIONS

PRODUCTIVITY IN R & D

(*Continued from page* 156)

training. During the interviews, the prospective employee talks with three or four experienced administrators. The man spends the full day (when not in an interview) with one of the company's young scientists.

The job offer, if tendered, is made by the person who wants the man and is often made on the spot during the interview. Frequent reviews of the man's progress are made after he has accepted a job; these are checked against interviewers' predictions.

Productivity of research and development people can be measured: about 50-80 per cent of the end products of research can be identified and measured—others are more difficult to assess. Some of the end products are new or improved products or processes, marked increase in sales, quality improvement, patents, customer service, and reports.

Forecasting productivity is a frustrating job. We can do best on measuring past productivity. An individual's productivity is harder to measure than a group's. The best thing to do is simply to list the individual's end products.

The real job of a research director is to get results rather than to measure productivity. These measurements do take a lot of time. What measurements are taken must be used properly by the research director himself. When research people are being questioned about productivity and creativity, it takes their minds off research.

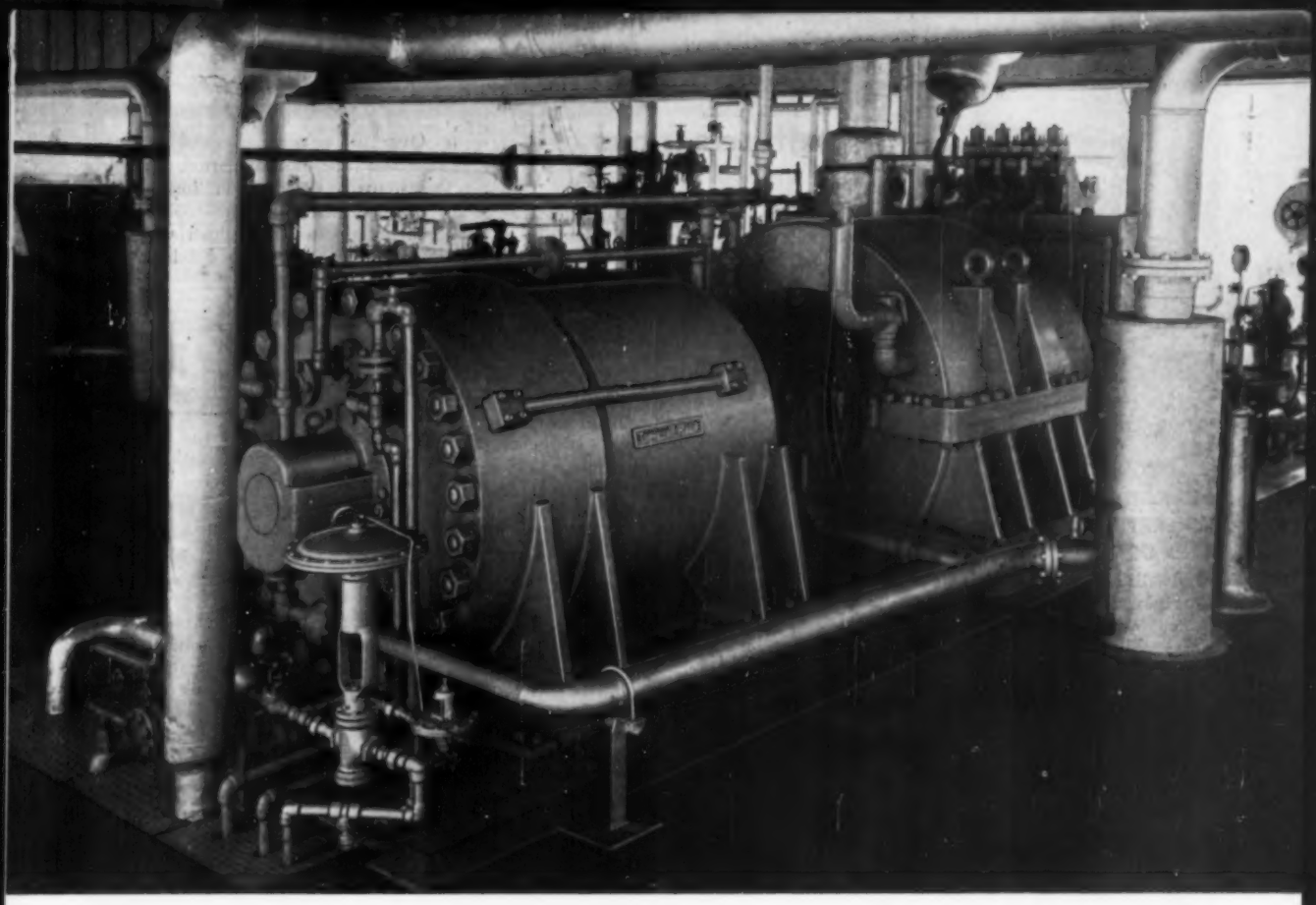
During the discussions, there was frequent mention of creativity—one very prominent member of the Institute felt that creativity was 2 per cent inspiration and 98 per cent perspiration. It was pointed out that the Industrial Research Institute has sponsored a project for some three years, attempting to determine whether or not creativity can be predicted by tests. Some definite progress has been made, since people who have proven to be creative give a consistent pattern of responses differing from the responses given by people who did not prove to be creative.

UNIT OPERATIONS

(*Continued from page* 154)

Most comment agreed that the generalized approach could be very useful for solving a wide variety of problems, provided the student was given

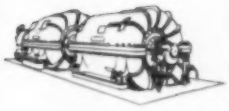
(*Continued on page* 160)



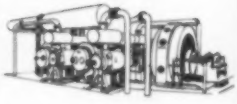
Putting the PRESSURE on low-grade naphthas to make high octane blending stocks

THE Ingersoll-Rand centrifugal compressor shown here handles hydrogen gas at high pressure – 5050 cfm at 675-psia discharge pressure. Driven by a 6340-hp I-R steam turbine, it is one of two duplicate machines installed as recycle compressor on a large catalytic reforming unit. This same refinery uses 19 additional I-R compressors.

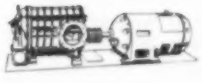
Ingersoll-Rand compressors are industry's first choice for high-pressure operation. Centrifugal compressors like the one shown here are now operating at pressures over 2,000 psi; I-R reciprocating compressors have been sold for pressures as high as 35,000 psi. So if your process calls for *putting on the pressure* you'll want to look into the complete line of I-R compressors. There's one that will be *just right* for your application. If necessary, a compressor can be designed specially for your application. Ask for your copy of form 3132-A, Process Compressors.



CENTRIFUGAL



RECIPROCATING



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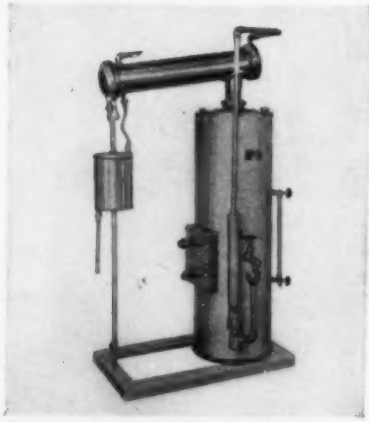
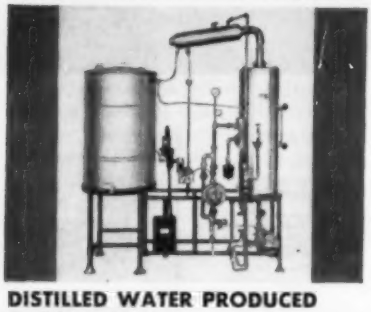


BARNSTEAD DISTILLED WATER WHERE FREEDOM FROM BACTERIA AND ORGANIC MATTER IS A MUST

The Barnstead Model SMQ-30 Steam Heated Water Still illustrated produces 30 gallons per hour of pure distilled water. This model features the Barnstead Spanish Prison Baffle within the evaporator for complete removal of pyrogens. It is suited to either hard or soft water areas. Ideal for larger laboratories and production work where freedom from bacteria and organic matter is important.



DISTILLED WATER PRODUCED AUTOMATICALLY

All Barnstead Stills can be furnished with full automatic controls for self-starting, self-stopping, and self-flushing. No manual attention whatsoever is required; the automatic controls start Still when storage tank level is low, stop the Still when the tank is full and flush sediment from the evaporator once every four hours during operation.

NEW LITERATURE: write for Demineralizer Catalog #127 and Barnstead Water Still Catalog "G".

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STILL & DEMINERALIZER CO.

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CHICAGO FInancial 6-0588	PHILADELPHIA LOcust 8-1796	LOS ANGELES RYan 1-9373
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82 Lanesville Terrace, Boston 31, Mass.

FIRST IN PURE WATER SINCE 1878

UNIT OPERATIONS

(*Continued from page* 158)

practice with some specific applications either in school or upon entering industry.

2) If schools should find that they could not cover *specific* material in Unit Operations, but only the more general principles of material and energy balances, rate processes, and equilibrium stages, would industry be willing to give specific information in their area of interest? In general the answer to the question was yes, although several believed that the more detailed knowledge of the Unit Operations was marketable today and should not be dropped, even though it might mean lengthening the stay in school.

3) One subject which should be included in undergraduate curricula is statistics and their application.

4) Present tendencies are toward bringing all branches of engineering closer together, with many attempts to have common courses in fluid mechanics, thermodynamics, etc.

5) A great need exists for bringing entering engineering students to a higher level of ability in mathematics.

Over 125 persons attended the session and time did not permit many to contribute their ideas on the subject. It was evident that the topic is of great interest among industrial people as well as in the academic field.

COST CONTROL

(*Continued from page* 154)

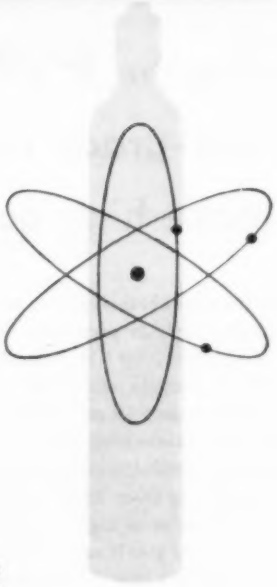
pointed out that, in any good cost control system, management must get enough information to avoid surprise. Everyone in the organization must be cost conscious and purchasing methods, as well as operating procedures, must be organized in such a way that production costs can be reasonably well predicted.

The group in general agreed that the best contribution to effective cost control and cost reduction is the enthusiasm with which all of the people in the organization work toward lower operating costs.

There was a considerable discussion of Author C. R. Bartels' reference to the "learning curve." Many new products are put into production quickly in order to meet sales deadlines, and sub-

(*Continued on page* 162)

Matheson Gas Mixtures for Nuclear Counting



Matheson offers prompt delivery on standard and custom mixed gases for all Nuclear Flow Counter requirements. Close quality control assures stable operating characteristics and optimum performance.

The following standard mixtures are available from our three plants in four cylinder sizes:

PROPORTIONAL COUNTING MIXTURES
90% Argon, 10% Methane
96% Helium, 4% Isobutane

GEIGER COUNTING MIXTURES
1.3% n-Butane, 98.7% Helium
0.95% Isobutane, 99.05% Helium

Special mixtures compounded to your specifications

Matheson offers a complete line of Automatic Pressure Regulators, Valves, Flowmeters and Special accessories for the accurate flow control vital to counting operations. Our Sales Engineering Department will be glad to help you choose the proper components for your requirements.

The Matheson Company, Inc.

Compressed Gases and Regulators — East Rutherford, N. J.; Joliet, Ill.; Newark, Calif.

Making better cells

The skills and experience of the men who renew electrolytic cells are a major factor in their economical performance.

Other significant factors include the quality, design and machining of **GLC anodes,** which are carefully "custom made" to the requirements of individual cells.

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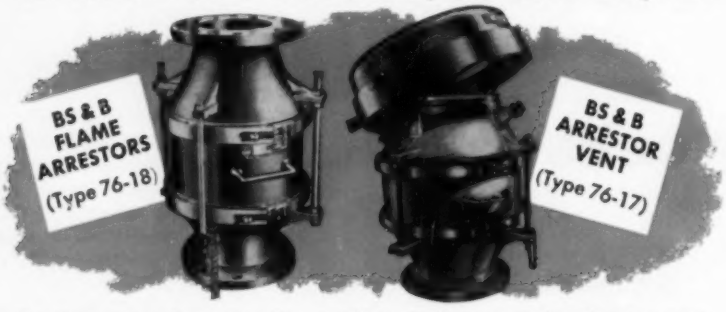
BS&B *Lightweight*
Tank Vents and Flame Arrestors

BS&B TANK VENT (Type 76-16) shown above features floating seal for positive shut-off under both pressure and vacuum, without using the weight of the hinged cover. Vapor pressure within the tank (or atmospheric pressure in the case of vacuum) maintains seal. Cover and major internal components are aluminum with stainless and plated steel hardware. Plastic coated bases are cast iron. These vents mount to 125-lb. ASA bolting circles. Sizes 6" through 12".



For free vent systems. May be mounted either horizontally or vertically. End connections are 125-lb. ASA flanged for mounting to open vent lines of process vessels. Flame-bank end flanges are identical to those of the Type 76-17 Arrestor Vent bases (at right). Light weight, maximum venting capacity and servicing ease are important features of the Flame Arrestor.

Combines the features of the other two types described here. Functions both as a tank breather and a cartridge-type flame arrestor to prevent ignited vapors from flashing back into the tank. Flame bank is secured by two quick-opening V-clamps for easy access to unit for inspection and servicing. Normal venting with the flame bank removed is maintained by simply securing the top unit to the base with one V-clamp. Internals of flame bank are alternate layers of flat and corrugated aluminum strips, in a continuous roll.

Ask your BS&B representative for Catalog 76-16 or write . . .

BLACK, SIVALLS & BRYSON, INC.

Safety Head — Vent Valve Division, Dept. 2-DX2
7500 East 12th Street • Kansas City, Missouri

COST CONTROL

(*Continued from page* 160)

sequently the manufacturer learns to produce that product more economically. The trend in cost reduction of such a product over the years as volume of production is increased was referred to as the learning curve, and the slope of this curve tends to indicate the efficiency with which costs are reduced on that product. It was pointed out that this learning curve concept applied to a wide variety of industries with comparisons given between pharmaceuticals and aircraft production. The effect of increased volume of production versus cost reduction due to causes other than volume increase were discussed at some length. The group generally felt that learning curves of their new products should be watched with interest to see how they compare with past performance.

The rewards which might be given to employees for cost reduction were another subject of discussion. This obviously has merit in building enthusiasm, but it also has some pitfalls. One question was raised as to whether the production department should be rewarded for accomplishing cost reductions in cases where the plant design group might properly be censured for extravagant or careless design.

It was emphasized throughout the discussion that cost controls should be planned as far as possible in advance and followed up closely to measure performance. However, no matter how carefully a plant is designed, it is almost inevitable that there will be opportunities for improving efficiency of operation and reducing costs of production.

PROJECT EVALUATION

(*Continued from page* 154)

"beaker to boxcar" were discussed.

One very pointed question concerned what acceptance an idea could expect if it originates in the production department. (Ideas do come from production people, you know!) The answer was that ideas are considered in a uniform manner, whether the origin is production department or research department.

There was some expression that the degree of research expenditures was dependent on whether the company was small or large (i.e. "one hoss" or multiple horse company). If the usual formula of 3 per cent of sales as a

(*Continued on page* 164)

ANNOUNCING THE NEW VOTATOR FILLER

for continuous, high-speed, accurate packaging

New 36-station VOTATOR Piston Type Filler has production rate as high as 1000 per minute. Other models with lower production rates are available.

GIRDLER has acquired all rights for the manufacture and sale of the fast, accurate "Librascope" Fillers. Thus, Girdler applies its 30 years of process industry experience and its precision-production facilities to bring you high standards of packaging economy.

By adding this new line of VOTATOR Fillers to its line of VOTATOR* Heat Transfer Apparatus, Girdler affords many manufacturers a closer integration of processing and packaging operations.

The new VOTATOR Fillers have distinctive improvements for more profitable packaging of many liquid and viscous products. They are fully described in Bulletin PED 257, free on request.

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ACE METAL JOINTS
IN STOCK FOR IMMEDIATE DELIVERY

7651 JOINTS, ⅋, Stainless Steel, interchangeable, full length. These joints are machined from 18-8 type 304 free machining stainless steel and are supplied in accordance with CS21-39 of the National Bureau of Standards. O.D. and I.D. dimensions approximately the same as the glass joints listed under 7565.

⅋ Desig.	⅋ Desig.	⅋ Desig.	⅋ Desig.
10/30	19/38	29/42	40/50
12/30	24/40	34/45	45/50

7651 ⅋ ⅋ 7658

7659 JOINTS, Spherical, fabricated from Brass. Specifications same as for 7658 stainless steel joints. Stocked in the following sizes:

⅋ Desig.	⅋ Desig.	⅋ Desig.
12/5	28/12	40/25
18/7	28/15	50/30
18/9	35/20	65/40
28/11	35/25	

7658 JOINTS, Ace Standard Spherical, fabricated from 18-8 type Stainless Steel No. 304 free machining. Can also be supplied from other metals made to order. Shanks are machined for thread sizes listed but are not threaded.

Desig.	Thread Size	O.D.	⅋ Desig.	Thread Size	O.D.
12/3	⅛"	.405"			
12/5	⅛"	.405"	35/25	1"	1.315"
18/7	¼"	.540"	40/25	1"	1.315"
18/9	¼"	.540"	50/30	1¼"	1.660"
28/11	½"	.840"	65/40	2"	2.375"
28/12	½"	.840"	75/50	2½"	2.875"
28/15	½"	.840"	102/75	†	†
35/20	1"	1.315"	130/100	†	†

†Available on request

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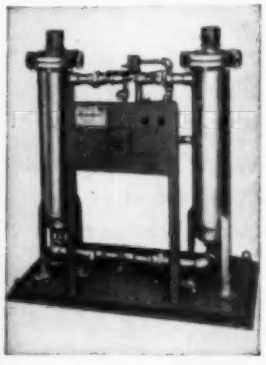

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Kahn has a complete line of electric or steam regeneration dryers–automatic, semi-automatic or manual operative. Operating pressures up to 5,000 psi.

Write for complete information.

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541 WINDSOR ST., Dept. A
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DISCUSSION SESSIONS

PROJECT EVALUATION

(Continued from page 162)

research budget applies, size makes no difference. The nature of the process and products would seem to govern more than size of company.

A very important statement was made that progress in a company is dependent directly on the vision of the management. The management must have confidence and must back its research—at least to the point where the project can be intelligently evaluated.

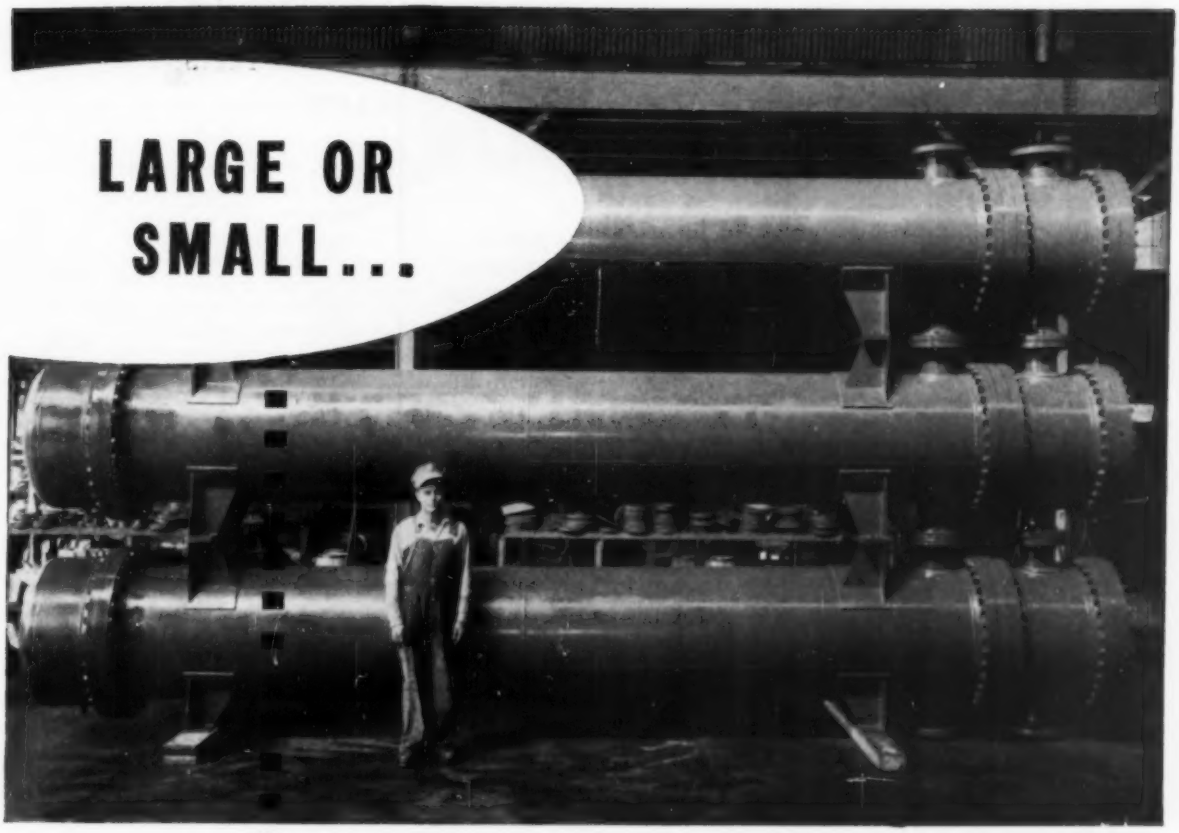
Books for Asian Students is a little-publicized means of increasing English literacy and of enlightening Asian scholars and students in the Western community of thought. In this special project of The Asia Foundation, a non-profit, non-political organization founded by private American citizens, over 580,000 books and journals have been distributed throughout 18 Asian countries in the two and a half years ending August 1957. The number of requests for more material is continually increasing.

Items in good condition, in every category on the college and university level published after 1945 are desired. Books by *standard* authors such as Dickens, Hawthorne, Hemingway, Plato, W. James, T. Huxley, etc., of any vintage are acceptable. Contributions may be made to **Books for Asian Students,** 21 Drumm Street, San Francisco 11, Calif. Transportation costs for substantial shipments to San Francisco from donors will be borne by the Foundation. □

An end is being sought to high-pressure recruiting of college students by industrial firms. "Principles and Practices of College Recruiting," published by the U. S. Chamber of Commerce and the College Placement Council, Inc., offers a single set of recruiting standards for voluntary acceptance by all colleges and employers. Highlights of their recommendations:

- Colleges should provide competent counselling services.
- Information provided to students concerning an employer should be strictly factual.
- No special bonuses or similar financial incentives should be offered by a prospective employer.
- Acceptance of an employment offer by the student should be made in good faith. □

LARGE OR SMALL...



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One reason that Efco does it *right* is its many years of experience in designing and fabricating heat-exchangers for the wide range of temperatures and pressures represented by ethylene plants and platinum catalyst reforming units. We are recognized specialists in handling all grades of carbon, alloy, and stainless steels, nickel, aluminum, and special low-temperature materials.

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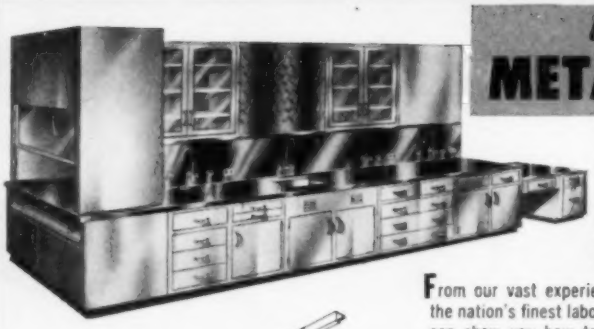

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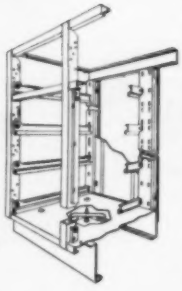
From our vast experience in laying out the nation's finest laboratories, METALAB can show you how to obtain maximum working and storage area in a minimum of space . . . how to make current equipment adaptable to any possible future needs . . . and how to achieve true economy in laboratory equipment. This know-how, plus the use of only the finest laboratory-tested materials, assures you of obtaining the most at Metalab for your laboratory budget.

Our Engineering Dept. will be pleased to solve your laboratory planning problems without any cost or obligation on your part. Write today for our literature!



Cutaway view of our standard base unit: This construction technique permits you to interchange drawers and cupboards by utilizing the same base cabinets as your laboratory requirements change.

METALAB mass-production methods, which have been adapted to custom laboratory equipment and furniture results in "custom" quality units at "standard" prices.

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METALAB *Equipment Company*
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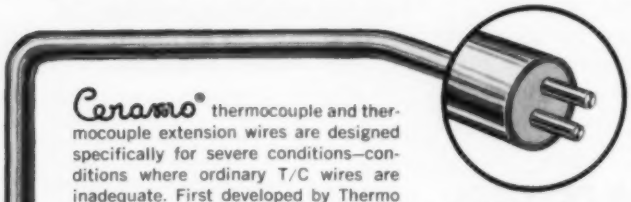
Ceramo® Thermocouple Wire Meets Severe Conditions

Where Durability, Hi-Temp Resistance Are Needed



Ceramo® thermocouple and thermocouple extension wires are designed specifically for severe conditions—conditions where ordinary T/C wires are inadequate. First developed by Thermo Electric, "Ceramo" wires incorporate ceramic insulation with overall metal sheathing. They'll solve your problems of high temperature, abrasion, chemical or corrosive action, pressure and difficult installation. You can bend them to almost any shape. As extensions, you can often use them without conduit. And under these conditions they'll outlast comparable standard types many times—with no significant difference in response. Choice of conductors in all standard calibrations and various sheath materials for temperatures up to 3000°F. Conductors—36 to 12 gage. Overall diameters—1/25" to 7/16" for thermocouples; ⅛" and ¼" for extensions.

Write for Bulletin No. 31-300-V.

Thermo Electric Co., Inc.
SADDLE BROOK, NEW JERSEY
In Canada—THERMO ELECTRIC (Canada) Ltd., Brampton, Ont.

MISSILE FUELS

(*Continued from page* 112)

availability in large concentrated deposits, added to high energy potential, determined the selection of boron as a component of HiCal and other high energy fuels, says George Huff, Callery's research and development director. Other candidates were hydrogen, beryllium, and lithium, all of which can produce energies significantly superior to hydrocarbon fuels. However, beryllium and lithium were ruled out, at least for the moment, on grounds of scarcity and toxicity, while hydrogen in molecular form is of low density and requires very low temperatures for storage purposes.

Chemical properties of boron are excellent, says Huff—"It forms more or less stable liquid compounds with hydrogen, the best chemical fuel. Modification of the boron molecules by the addition of hydrocarbon groupings gives fuels of the desired physical and chemical properties. As a supplementary benefit, the boranes generally have wider ranges of flammability than hydrocarbons, and consequently will allow operation of air breathing engines at higher altitudes than would be possible with conventional fuels."

Phillips-North American

Earlier, Phillips Petroleum and North American Aviation formed their joint company, Astrodyne, Inc. Solid propellants are the subject of interest at Astrodyne, and Phillips has been working on solid propellants since 1952. North American has worked mainly in liquid propelled rocket engines—its Rocketdyne Division is now delivering engines for the Thor, Atlas, Jupiter, and Redstone ballistic missiles.

More to Come

These three joint ventures are not the last. Other chemical and missile companies are known to be eyeing the high-energy fuel field, are considering the route of the joint venture.

In the meantime, borax production is rising rapidly, and small companies such as Bellvue Labs are trying to develop new methods and get into the field.

Dimethyl and diethyl phthalates are now in production at Kolker Chemical Corp.'s Newark, N. J. plant, which has a 50-million-pound annual production capacity for various plasticizers, including epoxides, phthalates, and phosphates. □

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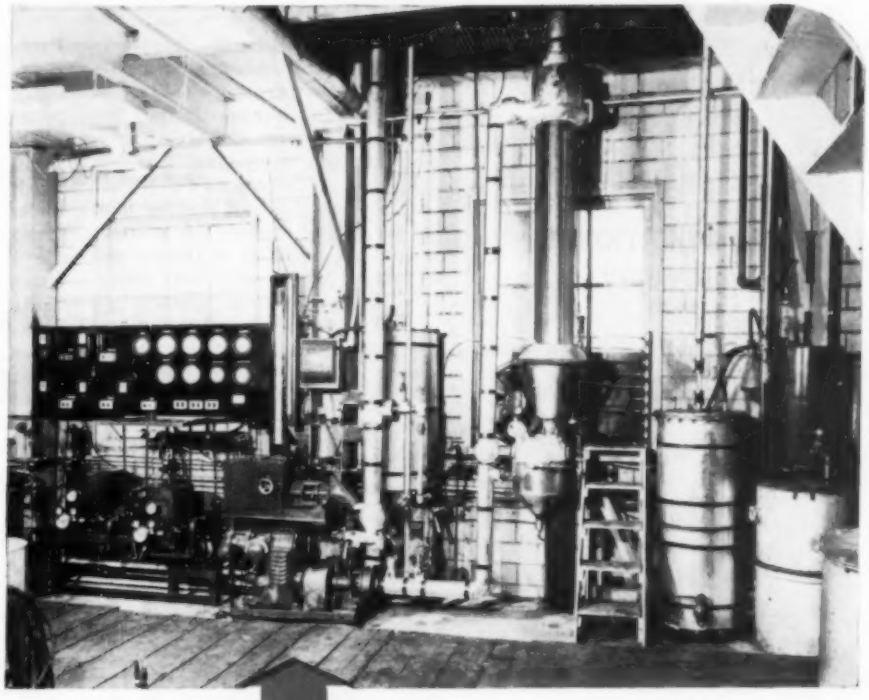

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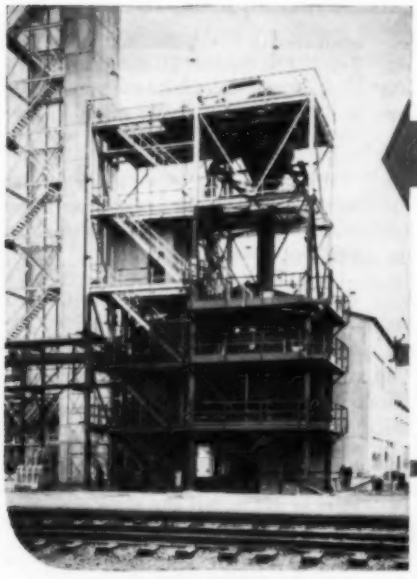

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Nuclear Applications Dept.

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washington feedback

Joseph L. Gillman, Jr.

The Role of Science

Washington is currently abuzz over President Eisenhower's having indicated that he personally will see to it that there is closer coordination and cooperation between the armed services through a reorganization of the Department of Defense.

It has been suggested that the Joint Chiefs of Staff become an advisory group to the Secretary of Defense and be stripped of authority over operations. Some important military men are making it known that the present system of cooperation with interservice competition is the only system that will give maximum military effectiveness.

Science, being currently accepted as an important key to the solution of all of our national and international problems, is coming in for the major portion of legislative and investigative interest. Defense Secretary McElroy has created a new civilian agency within the Defense Department, Advanced Projects Research Agency, and has appointed as its head Roy W. Johnson (on leave as of April 1 as vice-president in charge of Consumer Products Groups). The Agency is expected to be independent of the military services, has a $10 million budget. Its purpose is to control the development of, and to evaluate new weapons before they are turned over to the appropriate military services.

The State Department has appointed as its scientific adviser Wallace R. Brode, who has been Associate Director of the Bureau of Standards and currently is president of the AAAS. He is to be in charge of scientific attachés to be stationed in several U. S. Embassies abroad with the revival of a program that was suspended in 1955.

Senators McClellan (D. Ark.) and Humphrey (D. Minn.), have introduced a bill to coordinate and centralize all civilian scientific functions of the Government. This bill provides for the creation of a new Department of Science, to be headed by a cabinet member. This department would administer a scholarship fund and the collection of foreign scientific information. The bill presently provides for the transfer to the new Department of Science such agencies as Office of Technical Services, Atomic Energy Commission, National Science Foundation, Patent Office, National Bureau of Standards, and much of the Smithsonian Institution.

The Problem of Inflation

Several months ago, efforts were being made by the administration (and they were popular efforts at the time) to control inflation. But now, under the double threat of a business decline and fears of losing military supremacy, a high level of government spending seems to be growing in palatability. The president of a highly conservative New York State manufacturing concern that has faithfully served the chemical industry for about 75 years writes: "It seems to me that most of the prognosticators are trying to avoid the unescapable near-term prospects of a continuously receding level of business activity. Unfortunately, one always has to operate a business under current conditions, and today's conditions are not easy to live with. No matter how it is disguised, it seems evident that the powers that be have no other remedy for the current situation than to try another dose of inflation."

The House approved, by the astonishing vote of 374 to 0, a $549,670,000 emergency defense bill. Defense hardware orders will probably total $10 billion over the next six months, which compares to $14 billion for all of last year. The Senate Democratic Policy Committee cleared bills to give 500,000 postal employees raises from 7½ to 15% and 1,000,000 classified workers increases of 7 to 9%.

Unquestionably, the evidence at hand indicates the need for some prompt action. It also indicates the need for sober thinking.

Arthur F. Burns, until recently Chairman of the President's Council of Economic Advisers, provides the basis for some of this much-needed sober thinking in his just-published book, "Prosperity without Inflation":

"We may . . . reasonably expect that our economy will continue to grow rapidly. Setbacks in economic activity will undoubtedly occur from time to time. There will be declines as well as rises also in the price level. But if my analysis . . . is not too wide of the mark, the broad trend of the consumer price level seems likely to be gradually upward across the decades unless we learn how to manage our economic affairs better than we yet have. As far as the immediate future is concerned, the threat of inflation has definitely abated. But the problems of inflation will return to haunt us. There is no time to be lost in considering, realistically, the ways and means of checking the threat of creeping inflation."

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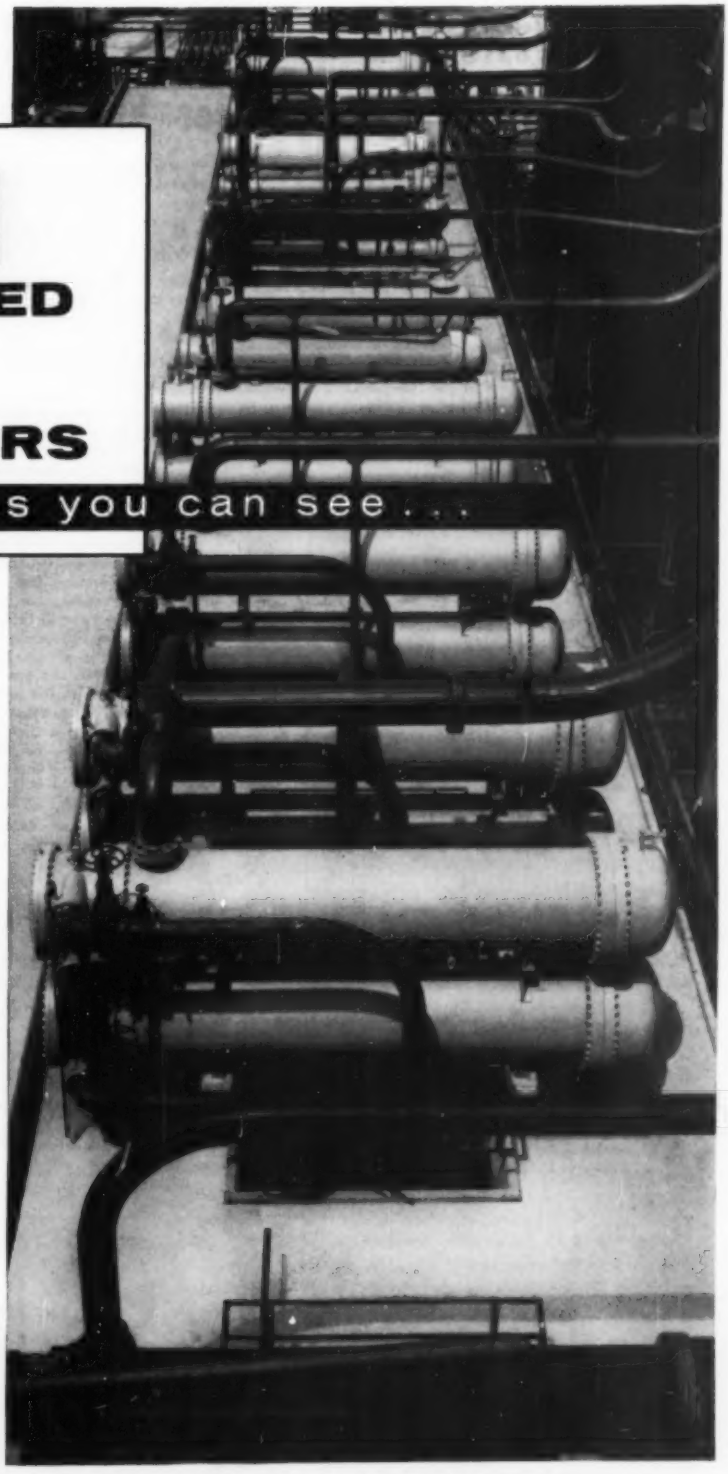
as far as you can see...



...and what you see is still only a fraction of the more than 100 heat exchangers giving trouble-free service in the high octane plant of the Continental Oil Co. at Ponca City, Okla. The Yuba units in this refinery have a total of 140,418 sq. ft. of heating surface.

Heat exchangers for petroleum refineries and for chemical plants can be built with Yuba's well-known *Multilok Closure* to handle volatile fluids at 1200 F and pressures at 6000 psi and higher. Heat exchangers in lower pressure-temperature ranges, where leakage is not a problem, have standard bolted flange construction.

Yuba's ability to outfit a process or an entire plant with heat exchange equipment is one of its outstanding accomplishments. Yuba's design efficiency helps a petroleum or chemical plant to achieve maximum heat economy and, as a result, helps it to lower its manufacturing costs significantly.

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CONTROLLED THERMONUCLEAR ENERGY

major breakthrough or mirage?

British and American researchers attain 5 to 6 million-degree energy level, termed important step toward sustained fusion reaction.

Important achievements on the road to production and control of thermonuclear reactions for the generation of power have been reported from laboratories at Los Alamos (U.S.) and Harwell (England). At Harwell, British scientists, working with their ZETA (Zero-Energy Thermonuclear Assembly) have sustained temperature levels up to 5 million degrees C. for periods of from 2 to 5 milliseconds; American workers at Los Alamos, using a similar but smaller apparatus, the Perhapsatron, have reached results "consistent with an effective temperature of about 6 million degrees C." for several microseconds.

Large numbers of neutrons have been produced in these experiments, which is regarded as highly significant since it indicates the probability of fusion reactions in the plasma. However, the origin of these neutrons has not been established beyond doubt. According to the British, "results obtained from the Harwell apparatus ZETA *suggest* that 'thermonuclear neutrons' have been obtained, but further experiments will be necessary before this can be proved conclusively." Reason for the qualification—it is known that, apart from true fusion reactions, so-called "false" neutrons can arise from instabilities in the gas itself or from collisions with the walls or the electrodes of the apparatus. (Kurchatov of the Soviet Union, in a lecture at Harwell in 1956, described the production of neutrons by the acceleration of deuterium ions due to electric fields in the gas).

How It Is Done

The basic goal in the production of thermonuclear energy is, of course, the attainment of sufficiently high energy levels to bring about the fusion of hydrogen nuclei to form helium nuclei. When four hydrogen nuclei combine to form one helium nucleus, the resulting helium nucleus weighs about 0.7 of 1% less than the sum of the original hydrogen nuclei, the difference in mass being converted into energy according to Einstein's equation, $E = mc^2$.

Light hydrogen cannot be so reacted under ordinary terrestrial conditions. Therefore, the only practical forms of hydrogen for use as thermonuclear fuels are deuterium and tritium.

The present approach to the problem of creating the enormously high energy levels necessary to bring about fusion is the passing of a strong electric current through a tube containing a low concentration of deuterium gas. By this means, an electric current is set up in the ionized gas (plasma). This electric current creates an intense magnetic field around the column of gas, which further constricts the gas and raises the temperature still higher.

The hot gas must be kept away from the walls of the containing tube, not because the walls would be vaporized (which is not the case, since comparatively small quantities of heat are actually involved), but because contact with the walls would cool the gas and tend to quench the reaction. The constricting magnetic field mentioned above is not sufficient to keep the column of hot gas from becoming unstable: this problem has been at least partially resolved by applying an additional magnetic field in a direction

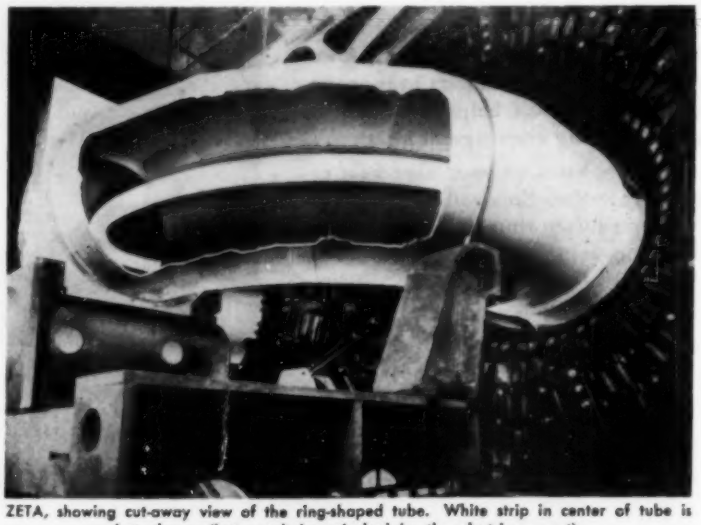
(Continued on page 172)

TECHNOLOGICAL BY-PRODUCTS

Practical applications of enormous immediate interest to the chemical engineer may well be by-products of the drive for the attainment of a controlled thermonuclear reaction. A device for the generation of a jet of plasma at atmospheric pressure in the 15 to 30,000° F. range is described by G. M. Giannini in *Scientific American* (August, 1957). According to Giannini, the apparatus is under development at the Knolls Research Laboratory of G.E. and at the Giannini Research Laboratory in California. Main features of the unit are said to be an electric arc and a cooling system which keeps the electrodes from vaporizing and helps to raise the temperature of the plasma.

According to Giannini, use of temperatures in this range (above the top limit of chemically-attainable figures) may lead to a whole array of new possibilities. Among his suggestions are:

- **Vaporization of any existing material,**
- **Alloying of metals in the vapor state,**
- **Purification of chemicals by controlled vaporization,**
- **Bonding of metals and ceramics.**



ZETA, showing cut-away view of the ring-shaped tube. White strip in center of tube is hot plasma (hot gas being pinched by the electric current).

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HYDROCHLORIC ACID... all concentrations

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CORROSIVE METALLIC SALT SOLUTIONS

DILUTE ACIDS

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PUMPING HEAD, CONNECTOR, VALVE HOUSING, INLET and OUTLET CONNECTIONS OF LAPP CHEMICAL PORCELAIN TUFCLAD ARMORED
ALUMINA OXIDE VALVE BALL
TEFLON VALVE SEATS
TEFLON DIAPHRAGM

Solid Lapp Chemical Porcelain, combined with parts of alumina ceramic and Teflon plastic, is used for the liquid end of this model of Lapp Pulsafeeder. All parts which can come in contact with liquid being pumped are non-metallic, chemically inert. Thus, positive-displacement metered pumping of "hard-to-handle" corrosive chemicals is made certain and permanently trouble-free.

WRITE FOR BULLETIN 440

with typical applications, flow charts, description and specifications of models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Division, 591 Poplar St., Le Roy, N. Y.

NOTHING ELSE LIKE IT!

Lapp Pulsafeeder is the combination piston-diaphragm pump for controlled-volume pumping of fluids. Reciprocating piston action provides positive displacement. But the piston pumps only an hydraulic medium, working against a diaphragm. A floating, balanced partition, the diaphragm isolates chemical being pumped from working pump parts—eliminates need for stuffing box or running seal. Pumping speed is constant; variable flow results from variation in piston-stroke length—controlled by manual hand-wheel, or, in Auto-Pneumatic models, by instrument air pressure responding to any instrument-measurable processing variable.

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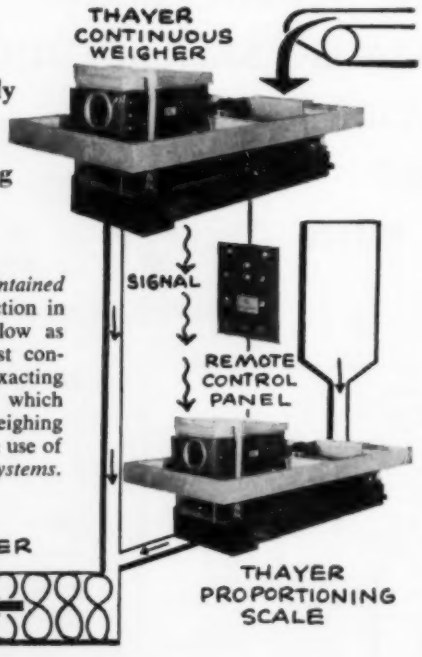
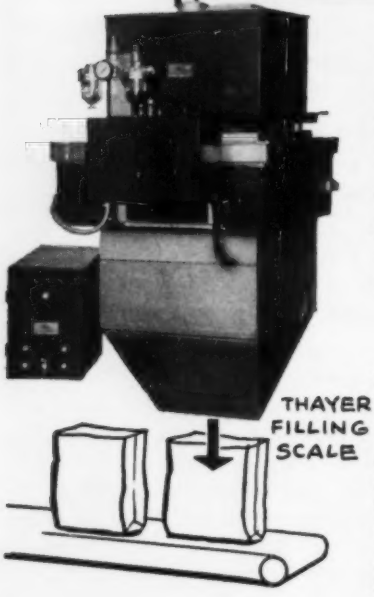


The high degree of accuracy *maintained* by *Thayer Scales* and the reduction in headroom requirements to as low as two feet, now provides low cost continuous formulating for many exacting processes. Formulation control which previously required batch weighing may now be accomplished by the use of *Thayer Continuous Weighing Systems.*



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Exclusive Leverage System Outperforms Other Scales

An extremely high degree of reliability is maintained through the exclusive use of the *Thayer Plate Leverage System* which is ***guaranteed accurate for the life of the scale.*** This unique scale has no knife-edge pivots to wear down and is not affected by dust, dirt, vibration or shocks.

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THERMONUCLEAR ENERGY

(*Continued from page* 170)

parallel to the axis of the containing tube.

The Gadgets

ZETA, in operation at Harwell since August, 1957, is a ring-shaped aluminum tube of 1 meter bore and 3 meters mean diameter, containing deuterium gas at low pressure (about 10^{-4} mm. Hg). The Perhapsatron, a small doughnut-shaped tube, went into operation at Los Alamos in December, 1957. Good results have also been achieved in the U.S. with "Columbus S-4," a straight porcelain pinch tube 5 in. in diameter and 24 in. in length.

How Far from the Goal?

Theoretically, the temperature necessary for a self-sustaining thermonuclear reaction using deuterium is of the order of 370 million degrees C.; for a half-and-half mixture of deuterium and tritium, about 50 million degrees. Technically, the use of tritium would seem to be indicated. However, there are ultimate economic obstacles. While deuterium, a constituent of ordinary water, can be produced in quantity at a reasonable cost, tritium occurs in nature only in trace amounts and must be manufactured—for instance, by the exposure of lithium to the action of slow neutrons—an extremely expensive process from a large-scale point of view.

No great doubt seems to exist in the minds of British and American experts that the necessary temperatures even for a pure deuterium reactor can be attained in somewhat larger and more refined equipment; the problem of sustaining the strength of the pulse for periods up to several seconds will probably be the most critical for the actual production of electric power.

An interesting possibility is the direct conversion of energy into electricity by harnessing the outward pressure of the heated deuterium plasma against the containing magnetic field.

Not Today—Not Tomorrow

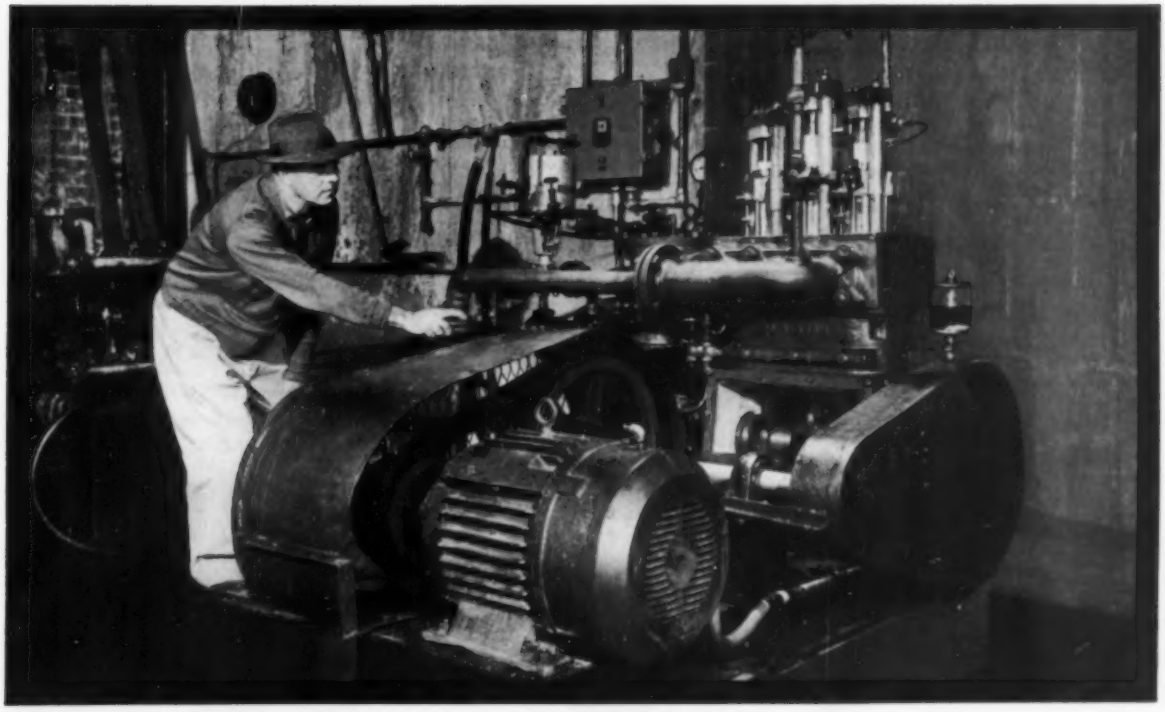
British and American atomic energy authorities alike are in agreement that no change is imminent in their plans for development of atomic power plants based on the fission process. Says Arthur Ruark, Chief of the

(*Continued on page* 174)

JACQUES WOLF & CO. SOLVES PROBLEM:

How to maintain constant, undeviating pressure in the production of highly corrosive chemicals

Precise, non-fluctuating pressures must be maintained in continuous processes at the Carlstadt plant of Jacques Wolf & Company. Erratic pressure caused by drop in volumetric efficiency could ruin an entire batch of costly material.



How Jacques Wolf solved the puzzle: Looking for an answer to the problem of holding constant pressure, plus that of increasing production, Jacques Wolf called on Aldrich. Aldrich engineers designed a pump which provided the proper corrosion resistance, fluid velocity and wear characteristics to insure dependable, continuous operation.

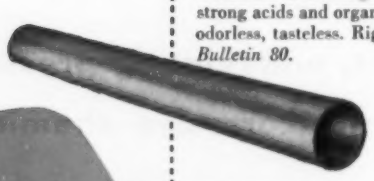
Result: After five months of use, the Aldrich Triplex Pump has met all guarantees and proven itself capable of continuous operation. Working 24 hour days, 6 day weeks, the Aldrich Triplex Pump provides the necessary pressure without fluctuation, efficiently handling both alkaline and acidic materials.

We'll be glad to send you full information on Aldrich Pumps and their advantages to you. Simply write Aldrich Pump Company, 20 Gordon Street, Allentown, Pa.

the toughest pumping problems go to ALDRICH

TOUGH ACE-ITE PLASTIC PIPE

General-purpose moderately priced rubber-plastic pipe handles most common chemicals to 170 deg. F. . . . except few strong acids and organic solvents. Tough, odorless, tasteless. Rigid pipe ½" to 6". *Bulletin 80.*



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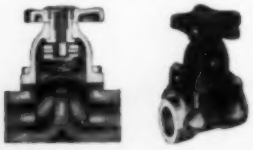
To prevent discoloration, taste, odor or metallic pick-up in your processes, you'll find the best, most economical piping, pumps, valves and tanks among the many ACE rubber and plastic materials. Wide range of temperatures, pressure, impact resistance. Phone nearest American Hard Rubber Company distributor, or write for Technical Data CE-50.

VALVES

for all-plastic piping systems



Trouble-free plastic diaphragm valves . . . choice of general-purpose ACE-ITE, ACE PARIAN (polyethylene) or ACE SARAN. Handles most corrosive chemicals and food ingredients. Sizes ½" to 2", 50 psi. at 77 deg. F. *Bulletins 80 and 351.*

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ACE RIVICLOR is a new rigid threaded plastic pipe with good aging and high impact strength. Not affected by most inorganic acids and alkalis, also excellent for many organics. Sizes ½" to 4". *Ask for Bulletin CE-56.*

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ACE processing equipment of rubber and plastics

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DIVISION OF AMERACE CORPORATION

NUCLEAR NEWS

THERMONUCLEAR ENERGY

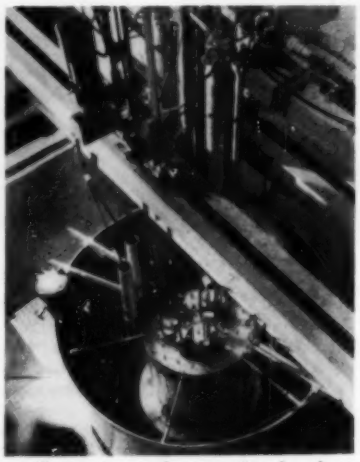
(*Continued from page 172*)

U.S.A.E.C. Controlled Thermonuclear Branch, "I would like to add a word of caution—we should not expect the early harnessing of fusion for the production of power. In this field we are not yet at the point comparable to the start-up of the first fission reactor in December, 1942."

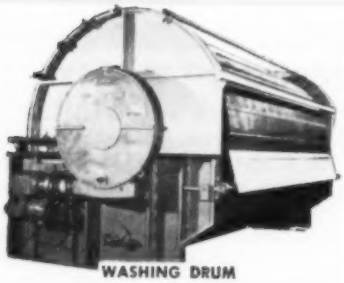
How the Temperature is Measured

Several methods are available for estimating the "temperature" of the hot plasma, none of which, however, conform exactly to ordinary thermodynamic conceptions of heat or its measurement. What is termed "effective temperature" can be calculated from the output of neutrons emitted during the discharge: the result is the temperature theoretically necessary, in a quiet plasma, to give the number of neutrons involved. A second approach is to make measurements on the light spectra emitted by the excited gas atoms.

AEC has filed notice of the proposed issuance of a permit to Aerojet-General Nucleonics, San Ramon, Cal., for construction of a semi-portable one-watt pool type reactor intended for operator training, demonstration, and use in education, medicine, and research. □



A self-sustaining nuclear reaction has been achieved in the reactor core of the Martin Package Power Reactor at The Martin Co.'s Baltimore zero power test facility. The reaction was obtained in the core, seen here, at a core loading of about 700 stainless steel clad, enriched uranium fuel tubes. The Martin Package Power Reactor is designed for use in self-contained packages adaptable to arctic, tropical, or temperate climates. It weighs from 6 to 15 tons, and is about 9 x 9 x 30 feet in size.



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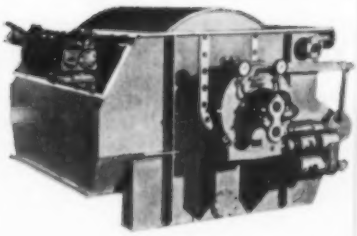
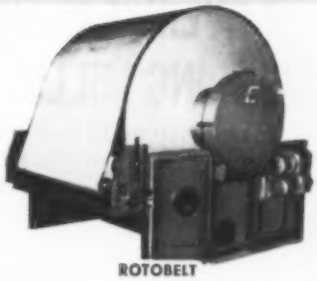


PRECOAT



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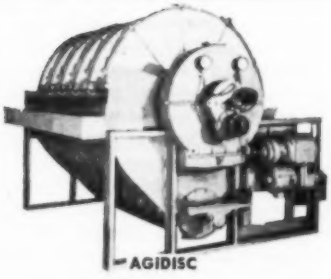

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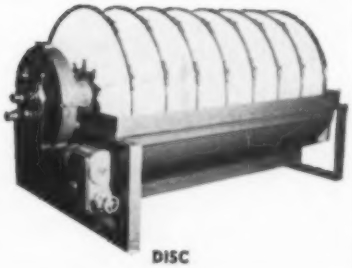
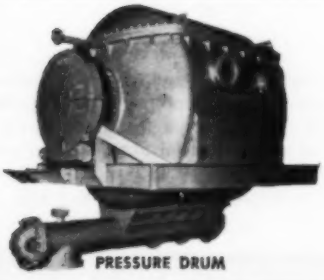
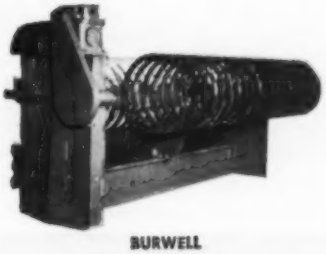


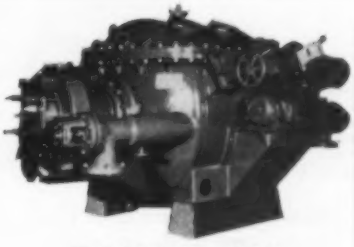
DISC



PRESSURE DRUM

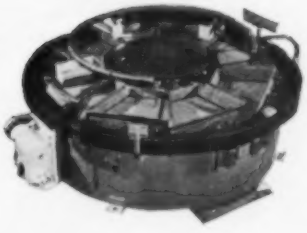


BURWELL

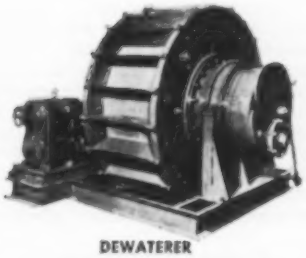


PRESSURE PRECOAT DRUM

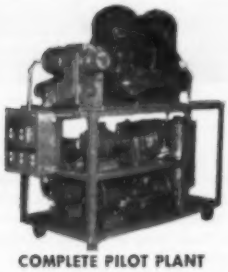
TOP FEED DRYER



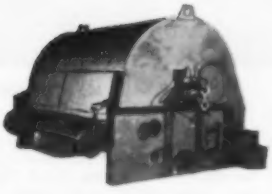
PAN



DEWATERER



COMPLETE PILOT PLANT



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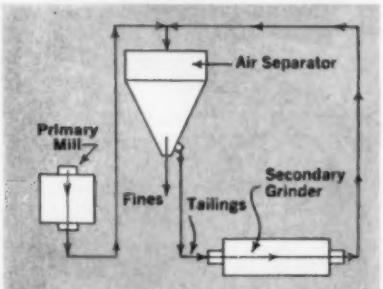

STURTEVANT CLOSED CIRCUIT SYSTEM: Primary Mill runs open, load is circulated through air separator. Desired fines are discharged. Oversize recirculates to secondary grinder and then to air separator for further classification.

Current users of Sturtevant Air Separators include manufacturers of sulfur, soybeans, phosphate, chocolate, feldspar, sand, pigments, limestone fillers, abrasives, plasters, ceramics and cement.

Sturtevant Air Separators Can Lower Power Costs Up To 50%

Production capacity impossible in single-pass grinding results from using Sturtevant Air Separators in closed-circuit grinding systems. They are of proved advantage in all secondary reduction processes.

Fines pass through grinding mills unhindered, are classified, and the oversize returns for further grinding. Grinding mills are free to perform at top efficiency, their output frequently increased as much as 300% and power costs cut up to 50% (documented by 30 years of Sturtevant air separation experience in the cement industry).

Precise Classification; Circulates Loads of 800 tph

Sturtevant Air Separators circulate production loads of up to 800 tph. Simple adjustments make possible counter-action between air currents and centrifugal force to the point where a product of almost any desired fineness may be collected while coarser sizes are rejected.

A 16 FT. STURTEVANT, for example, took a feed rate of 800 tph, containing only a small percentage of desired fines, and delivered 30 tph 90% 200 mesh, recirculating the oversize through the grinding circuit. (In the cement industry, Sturtevant units deliver up to 60 tph raw cement fines, 40 tph finished cement fines.)

Nine models available, diameters from 3 to 18 ft. For more information, request Bulletin No. 087. (Bulletins also available on Micronizers, Blenders, Crushers, Grinders.) Write STURTEVANT MILL CO., 135 Clayton St., Boston, Mass.

NEW REACTOR CONCEPT STUDIED

An advanced nuclear reactor concept will be studied by Atomics International with the ultimate goal the construction of one or more full scale atomic plants.

An agreement recently signed between Atomics International (a division of North American Aviation) and Southwest Atomic Energy Associates sets up a four-year research and development program by Atomics International to determine the economic feasibility of the Advanced Epithermal Thorium Reactor (AETR) concept. Cost: $5,354,000.

The AETR concept involves, primarily, the use of sodium as a coolant to transfer heat from the reactor core. Uranium 233 would be the fuel. If the reactor were moderated, beryllium or graphite would be the moderator. Such a reactor would be rated at approximately 200,000 electrical kilowatts.

Under this concept, thorium is the fertile material—i.e., the material which is converted to uranium 233, a fissionable element, in the "breeding" process. The uranium thus produced, plus the uranium originally put into the reactor, will be the fuel. The term "epithermal" refers to the intermediate speed of the neutrons in this type of reactor—they are neither slow nor fast.

AEC has reviewed the proposed study already, has indicated that the program appears to be a logical extension of work now in progress in the Commission's program for the development of sodium cooled, graphite moderated civilian power reactors. The program will fit with Atomic International's Sodium Reactor Experiment now operating for AEC near Los Angeles. The other AEC program experiment currently being operated by Atomics International is the Organic Moderated Reactor Experiment at AEC's National Reactor Testing Station in Idaho.

Nearly 200 industrial companies started using radioactive by-products in 1957, according to a survey of the Atomic Industrial Forum. This brings the total of U.S. industries using radioactive materials up to 1,316. □

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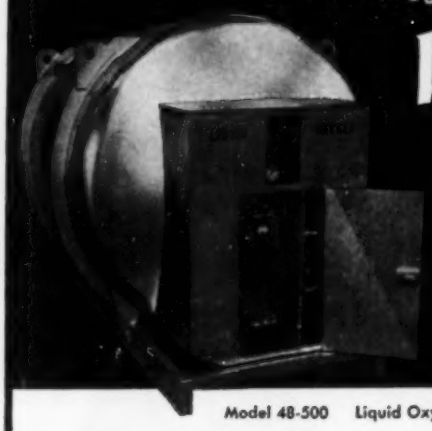

Model 48-500 Liquid Oxygen — Nitrogen Unit

These low-loss storage and transport units are skid, caster, wheel and trailer mounted and are available in capacities to 3500 gallons. Larger vessels for bulk liquid storage are sized to 10,000 gallon capacities. All units feature standard equipment as follows: bottom fill and discharge line, top fill line, liquid level gauge, vacuum valve and filter, thermocouple vacuum gauge, pressure gauge, A.S.M.E. code stamped inner vessels, quick pressure build-up system, extended stem valves on liquid lines, ending with Hofman quick couplings.

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HEAT TRANSFER GROUP ORGANIZED IN A.I.Ch.E.

The new Heat Transfer Group of A.I.Ch.E. will handle all program matters involved with the heat transfer area, will represent the Institute in holding the future national heat transfer conferences in cooperation with ASME, and will conduct all other matters in the field of heat transfer that are of service to chemical engineering.

The new Group was organized by preparing a list of members interested in heat transfer, and by electing an Executive Committee. Members of this Committee are: S. W. Churchill, T. B. Drew, C. H. Gilmore, D. Q. Kern, J. G. Knudsen, A. C. Mueller, D. L. Katz, and G. C. Williams. A. S. Foust and A. N. Addoms are *ex officio* members by virtue of their chairmanship of the technical program for the Heat Transfer Conference held recently in cooperation with ASME.

At present the Executive Committee is preparing by-laws for submission to the Program Committee and Council of the Institute in order to become a full-fledged division of the Institute.

At the Chicago Annual Meeting in December, the new Executive Committee went right to work discussing the future division with interested members, and attended the Conference Committee which is planning a Heat Transfer Conference at Northwestern U. in August. This will be another joint conference with ASME, and this time A.I.Ch.E. will act as the host society.

CHEMICAL ENGINEERING HONORARY SOCIETY INSTALLS NEW CHAPTER

A student chapter of Omega Chi Epsilon, national honorary chemical engineering fraternity, has been established at the Newark College of Engineering. Organized to recognize and promote high scholarship and original research in chemical engineering, the national society has its headquarters at the University of Texas, Austin, Tex.

On hand to install the new chapter officially was Donald Keyes, past national president of the society and one of its founders.

Joseph Joffee, professor of chemical engineering at Newark, will be faculty adviser. Officers will be H. Barner, E. Corino, M. Fenchynsky, and G. Permutt.

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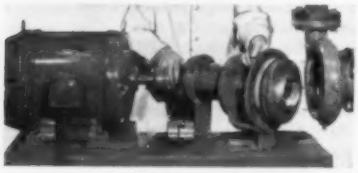
Unbolt back head and cradle combination assembly from casing.



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future meetings

■ **1958 MEETINGS—A.I.Ch.E.**

• Chicago, Ill., March 17-21, 1958, Chicago International Amphitheatre. **1958 Nuclear Congress.** Managed by A.I.Ch.E. Coordinated by E.J.C. Prog. Chmn: J. W. Landis, Babcock & Wilcox Co., New York, N.Y. Congress Mgr.: J. Henry, A.I.Ch.E., N.Y. Will include: 4th Nuclear Engineering and Science Conference, 4th International Atomic Exposition, 6th Atomic Energy in Industry Conference, 6th Hot Laboratories and Equipment Conference, and the American Power Conference. For details of program see page 187.

• Newark, Delaware, April 2-4, 1958. University of Delaware. **Conference on Automatic Optimization.** Sponsored by A.S.M.E., co-sponsored by A.I.Ch.E. and other groups. Program will comprise four technical sessions and a panel discussion.

• Montreal, Canada, April 20-23, 1958. Sheraton-Royal Hotel. **Joint A.I.Ch.E.—C.I.C. Conference.** For details of program see page 185.

• Berkeley, California, June 19-21, 1958. Dwinelle Hall, University of California. **1958 Heat Transfer and Fluid Mechanics Institute.** Co-sponsored by A.I.Ch.E. and other groups.

• Philadelphia, Pa., June 22-27, 1958. Bellevue-Stratford Hotel. **50th Anniversary Jubilee Meeting of A.I.Ch.E.** Gen. Chmn: W. E. Chalfant, Atlantic Refining, Philadelphia, Pa. **Future Trends in the Fundamentals of Chemical Engineering** (2 sessions). **The Place of Chemical Engineering in the Nuclear Field** (1 session). **What's Ahead in Kinetics and Reactions** (2 sessions). **The Changing Field of Unit Operations** (4 sessions). **Chemical Engineering Education—Undergraduate, Graduate, and Industrial** (3 sessions). **Materials of Construction in the Future—Metals and Non-Metals** (2 sessions). **Moving Forward in the Control of Chemical Processes** (2 sessions). **The Management of Chemical Industries in 1965** (2 sessions). **A Look Ahead in the Economics of Manufacturing Chemicals** (1 session). **The Shape of the Future—Raw Materials, Energy, Capital, Human Resources** (1 session). For further details see page 183.

• Evanston, Ill., August 18-21, 1958. **A.I.Ch.E.-A.S.M.E. Heat Transfer Conference,** Northwestern U. Technological Inst. Tech. Prog. Chmn.: A. S. Foust, Dept. of Chem. Eng., Lehigh University, Bethlehem, Pa. Deadline for papers: March 15, 1958.

• Salt Lake City, Utah, Sept. 21-24, 1958. Hotel Utah. **A.I.Ch.E. National Meeting.** Gen. Chmn: R. J. McNally, Amer. Smelting and Refining, Salt Lake City, Utah. Tech. Prog. Chmn.: E. B. Christiansen, Dept. of Chem. Eng., Bldg. 437, Univ. of Utah, Salt Lake City. **Air Pollution**—W. L. Faith, Air Pollution Foundation, 704 S. Spring St., Los Angeles 14, California. **What's New in Liquid Metals Technology**—Marshall Sittig, American Lithium Institute, Inc., P.O. Box 549, Princeton, N.J. **Crystallization**—H. M. Schoen, American Cyanamid Co., 1947 West Main St., Stamford, Conn. **Foams and Froths**—J. Louis York, Dept. of Chemical Engineering, Univ. of Mich., Ann Arbor, Mich. **Ethylene**—Hermann C. Schutt, 201 Devonshire Street, Boston, Mass. **Polar-Nonpolar Thermodynamics**—J. M. Smith, Dept. of Chem. Eng., Northwestern Univ., Evanston, Ill. **Petroleum Substitutes**—J. M. Hirsch, Gulf Research & Dev. Co., P.O. Drawer 2038, Pittsburgh 30, Pa. **Filtration and Centrifugation**—J. O. Maloney, Univ. of Kansas, Lawrence, Kansas. **Intermountain Industries**—W. C. Bauer, Intermountain Chem. Corp., Box 872, Green River, Wyoming. **High Temperature Chemical Kinetics and Transport Phenomena**—W. R. Marshall, Univ. of Wisconsin, Madison, Wis. **Dry Classification of Solids**—D. W. Oakley, Metal and Thermit Corp., 100 Park Ave., New York, N.Y. **Safety in Air and Ammonia Plants**—N. H. Walton, Atlantic Refining, 3144 Passyunk Ave., Philadelphia 1, Pa. **Petroleum Production**—F. H. Poettman, Ohio Oil Co., P. O. Box 269, Littleton, Colo. **Increasing the Effectiveness of Chemical Engineers**—J. F. Cheely, Ethyl Corp., Box 341, Baton Rouge, La. **Petroleum Refining**—L. W. Russum, Standard Oil Co. (Indiana), Whiting, Ind. Deadline for papers: May 21, 1958.

• Cincinnati, Ohio, December 7-10, 1958. Netherland Plaza Hotel. **A.I.Ch.E. Annual Meeting.** Tech. Prog. Chmn.: A. C. Brown, Emery Industries, Inc., June & Long Streets, Ivorydale, Ohio. **Pollution Control by In-Plant Measurements**—C. Fred Gurnham, Dept. of Chem. Eng., Michigan State U., East Lansing, Michigan. **A.I.Ch.E. Research on Bubble Tray Efficiency**—W. C. Schreiner, M. W. Kellogg Co., 711 Third Ave., New York 17, N. Y. **High-Speed and Time-Lapse Photography in Chemical Engineering**—J. W. Westwater, William Albert Noyes Laboratory, Univ. of Illinois, Urbana, Ill. **Kinetics & Rate Processes**—H. E. Hoelscher, Dept. of Chem. Eng., John Hopkins Univ., Baltimore 18, Md. **Reprocessing of Fluid Reactor Fuels**—O. E. Dwyer, Chem. Eng. Div., Brookhaven National Laboratory, Upton, L.I., N.Y. **The Application of Computers to Heat and Mass Transfer Problems**—J. M. Smith, Northwestern Univ., Evanston, Ill. **Low Temperature Processing**—C. McKinley, Air Products, Inc., Allentown, Pa. **Applied Heat Transfer**—

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W. W. Akers, Dept. of Chem. Eng., Rice Institute, Houston, Texas. **Scale-up from Pilot Plant to Plant**—D. B. Coghlan, Foote Research and Development Laboratories, Berwyn, Pa., R. A. Schulze, DuPont Chambers Works, Jackson Labs., Penns Grove, N. J. **Guideposts in Long Range Planning**—H. E. Wessel, Virginia-Carolina Chemical Corp., 401 Main St., Richmond, Va. **Processing of Irradiated Fuels—A Challenge for the Future**—J. L. Schwennesen, A.E.C., P.O. Box 1221, Idaho Falls, Idaho. **Round Table Discussion on Rubber**—C. C. Winding, Cornell Univ., Ithaca, N.Y. **Spray Mechanisms**—J. F. Tourtellotte, Swenson Evaporator Co., 18505 James Couzens Highway, Detroit, Mich. **Polyisoprene Potentialities**—C. C. Winding, Cornell Univ., Ithaca, N.Y. Deadline for papers: August 7, 1958.

■ 1958 MEETINGS—NON-A.I.Ch.E.

• New York, N.Y., March 5, 1958. Shelburne Hotel. **Spring Meeting of Association of Consulting Chemists and Chemical Engineers.**

• Brussels, Belgium, May 28-29, 1958, and Frankfurt am Main, West Germany, May 31-June 8, 1958. **Congress of the European Federation of Chemical Engineering** and **ACHEMA Congress.** Papers will deal with recent results in research and development.

• Atlantic City, N.J., June 4-6, 1958. Hotel Traymore. **Thirteenth Annual National Meeting of Armed Forces Chemical Association.**

• London (Olympia), England, June 18-28, 1958. **Chemical and Petroleum Exhibition,** sponsored by British Chemical Plant Manufacturers Association and Council of British Manufacturers of Petroleum Equipment. Symposium on **The Organization of Chemical Engineering Projects,** organized by the Institution of Chemical Engineers and the Institute of Petroleum (4 sessions).

• Geneva, Switzerland, Sept. 1-13, 1958. **Second International Conference on the Peaceful Uses of Atomic Energy.**

■ 1959 MEETINGS—A.I.Ch.E.

• Atlantic City, N.J., March 16-20, 1959. **A.I.Ch.E. National Meeting.** Chalfonte Haddon Hall Hotel. **Recent Advances in Polymeric Materials of Construction**—M. F. Cigliotti, Monsanto Chem. Co., Plastics Div., Springfield, Mass. **Business and Technology**—K. Watson, Dept. of Chem. Eng., Illinois Institute of Technology, Chicago 16, Ill. **Laboratory and Pilot Plant Techniques**—G. W. Blum, Goodyear Tire and Rubber Co., Akron, Ohio. **Rocket Propulsion**—J. L. Franklin, 3710 Harrison N.W., Washington 15, D.C. **General Papers** (2 sessions)— J. Joffe, Newark College of Engineering, 367 High St., Newark 2, N.J. and E. C. Johnson, Dept. of Chem. Eng., Princeton Univ., Princeton, N.J. Deadline for papers: November 16, 1958.

• Kansas City, Missouri, May 17-20, 1959. **A.I.Ch.E. National Meeting.** Gen. Chmn: F. C. Fowler, Midwest Research Institute, 1457 E. 76th Terrace, Kansas City, Missouri. Tech. Prog. Chmn.: Fred Kurata, Chem. Eng. Dept., Univ. of Kansas, Lawrence, Kansas. **Reaction Kinetics**—R. R. White, Dept. of Chem. Eng., Univ. of Michigan, Ann Arbor, Mich. **How to Become a More Proficient Technical Engineer. Heavy Chemicals. Reservoir Engineering**—M. J. Rzasa, Cities Service Research and Development Co., 60 Wall St., New York, N.Y. **Petrochemicals**—G. E. Montes, National Petrochemical Corp., Tuscola, Ill. **International Licensing and Collaboration**—R. Landau, Scientific Design Co., 2 Park Ave., New York, N.Y. **General Papers**—J. O. Maloney, Univ. of Kansas, Lawrence, Kansas. Deadline for papers: January 17, 1959.

• San Francisco, Calif., December 6-10, 1959. **A.I.Ch.E. Annual Meeting.** Gen. Chmn: Mott Souders, Jr., Shell Development Co., 4560 Horton St., Emeryville 8, Calif. Tech. Prog. Chmn.: C. R. Wilke, Div. of Chem. Eng., Univ. of Calif., Berkeley, Calif. **Process Dynamics**—E. F. Johnson, Dept. of Chem. Eng., Princeton Univ., Princeton, N.J. Deadline for papers: August 6, 1959.

UNSCHEDULED SYMPOSIA

Correspondence on proposed papers is invited. Address communications to the Program Chairman listed with each symposium below.

• **Size Reduction:** Edgar L. Piret, Chem. Eng. Dept., U. of Minnesota, Minneapolis 14, Minn.

• **Filtration & Centrifugation:** Horace Hinds, Jr., Basic Vegetable Prod. Co., Vacaville, Calif.

• **Chemical Engineering Process Dynamics as They Affect Automatic Control:** David M. Boyd, 315 Ridge Ave., Clarendon Hills, Ill.

• **The Threatened Imbalance Between Chlorine and Alkali in American Chemical Industry:** Zola G. Deutsch, Deutsch & Loonam, 70 E. 45th St., New York City 17.

• **Start-Up of New Chemical Plants:** M. L. Nadler, Du Pont, Wilmington, Del.

• **Computers in Optimum Design of Process Equipment:** Chen-Jung Huang, Dept. of Chem. Eng., Univ. of Houston, Cullen Blvd., Houston 4, Texas.

• **Financing for the Chemical Industry:** Bernard Stott, First National City Bank of New York City, New York, N. Y.

(Continued on page 181)

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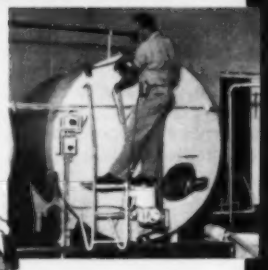

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INDUSTRIAL NEWS

Construction of a $2-million lime reclamation plant will be started immediately by National Carbide Co. at Calvert City, Ky. The plant will recover calcium oxide from the residue of a calcium carbide-to-acetylene gas operation. It will use a newly-developed NCC process to reclaim calcium oxide for reuse in the manufacture of calcium carbide. Previously, calcium oxide could be used just once—with this process it can be reused repeatedly. The reclamation process consists of taking wet calcium hydroxide (residue left when acetylene gas is generated from calcium carbide), partially dewatering by centrifuging, and feeding to a rotary kiln where free and bound water are heated off. The remaining calcium oxide is briquetted for reuse in calcium carbide furnaces. The recovery plant will produce 250 to 300 tons of reclaimed material daily. Plans include the building of a similar recovery plant at Louisville, Ky. Each plant is expected to employ about 20 men. □

Twin generating plants produce 230 tons/day of high purity (99.5%) oxygen for Jones & Laughlin's new basic oxygen steel-making process at Aliquippa, Pa. The oxygen plants were designed, built, and are being operated by Air Products, Inc. of Allentown, Pa. Cyclic demand, reliability of supply, and safety requirements dictated the use of the tandem system in conjunction with a 6½-million cu. ft. storage unit for high pressure and liquid oxygen. Very pure argon and 99.9% pure nitrogen are by-products of the system. □

Price reductions on its Versene chelating agents were announced by Dow effective the first of the year. At the same time, pricing of the compounds was put on a commodity basis rather than a specialty basis. Also down are the announced prices of lithium hydroxide and carbonate from American Potash & Chemical Corp. It is expected that the lower prices, which are possible because of larger quantities now available, will expand the market for lithium compounds. □

Plans for a "large" hydrofluoric acid plant at Louisville, Ky., have been made public by Stauffer Chemical. Decision to build, according to Stauffer, was motivated by increased demand for hydrochloric acid in the manufacture of refrigerants, aerosol propellants, aviation gasolines, rocket propellants, and as a processing chemical for uranium. □

What is claimed to be the country's first facility for making glacial acrylic acid in large commercial quantities is expected to go on stream early in 1958 at the B. F. Goodrich plant in Calvert City, Ky. The unit will have a yearly capacity of several million pounds. The new plant will be integrated for the production of related acrylic resins including: a processing size for nylon, a foundry corebinder, and additives for use in pharmaceutical, cosmetic, and paint formulations. □

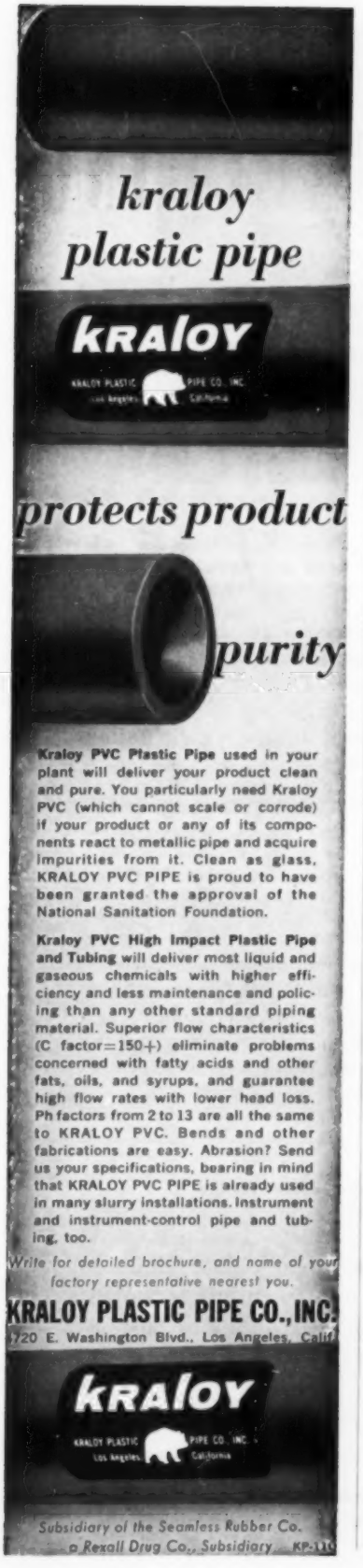
Construction on the Navy's $38 million high-energy boron fuel plant at Muskogee, Okla., moves ahead as a $3,400,000 contract for hydrogen, nitrogen, and carbon producing and purifying units is awarded to Girdler by Callery Chemical, prime contractors for the complete job. Target date for the integrated plant is late 1958. □

Dow Chemical of Canada has joined with Rio Tinto Mining Co. of Canada to form a new company, Rio Tinto-Dow Ltd., which will concentrate on the production of thorium and rare earths from by-product materials of uranium mining operations in the Blind River area of Ontario. □

More than 75 tons of liquid oxygen, nitrogen, and argon will be produced daily at the recently-dedicated air liquefaction plant of Air Reduction Pacific Co. in Los Angeles. Built by Bechtel at a cost of $7,500,000, the new plant will service industrial, commercial, military, and medical clients in Southern California, Arizona, and Nevada. □

A contract to design, engineer, and construct a 75 million cu. ft./day gas treating and dehydration plant has been awarded to Fluor Corp. Client: Transcontinental Gas Pipe Line Corp. in McMullen County, Texas. The $2 million installation will remove acid and water from gas before it is sent through the line, thereby reducing corrosion of the line. □

Regular and special types of nylon 6 plastic materials will be manufactured and sold in this country by Foster Grant Co., Leominster, Mass., under the terms of a licensing agreement recently concluded with Farbenfabriken Bayer of Germany. The agreement permits Foster Grant to import and sell Bayer nylon products until equipment can be installed here to utilize the Bayer processes. □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future meetings

(Continued from page 179)

- **Chemical Engineers in Chemical Industry Management:** T. P. Forbath, American Cyanamid Co., 488 Madison Ave., New York, N. Y.
- **Training on the Job for Industry:** John Happel, Dept. of Chem. Eng., N. Y. University, University Heights, New York 53, N. Y.
- **Alternate Energy Sources:** Henry F. Nolting, Standard Oil Co., Whiting, Ind.
- **Thermodynamics of Phase-Equilibria:** E. H. Amick, Dept. of Chemical Engineering, Columbia Univ., N. Y.
- **Properties of Liquids:** S. E. Isakoff, Engineering Research Laboratory, Du Pont, Wilmington, Del.
- **Preparation of Catalytic Cracking Charge Stocks and Quality Criteria Therefor:** Wheaton W. Kraft, Lummus Co., 385 Madison Ave., New York 17, N. Y.
- **Solar Energy Research:** J. A. Duffie, Director of Solar Energy Laboratory, Univ. of Wisconsin, Madison, Wis.
- **Mechanics of Fluid-Particle Systems:** S. K. Friedlander, Dept. of Chem. Eng., Johns Hopkins Univ., Baltimore 18, Md.

In addition to the above, the following symposia in the management area are available from J. Happel, Dept. of Chem. Eng., New York Univ., University Heights, New York, N.Y.:

- **Market Research • Financing • Growth of the Chemical Industry • Distribution between Dividends and Growth in Financing • Stock Market Analysis for Chemical Companies • International Growth • Filling Vacancies in Top Management • Duties of a Good Director • Where Chemical Engineers Go After Graduation • Long Term Planning.**

AUTHOR INFORMATION

Submitting Papers

Procedure to be followed is, in brief:

1—Obtain four copies of "Proposal to present a paper before the A.I.Ch.E.," plus one copy of "Guide to Authors" from Secretary A.I.Ch.E., 25 West 45th St., New York 36 N. Y.

2—Send one copy of completed form to Technical Program Chairman for meeting selected from above list.

3—Send another copy to Mr. E. R. Smoley, The Lummus Co., 385 Madison Ave., New York 17, N. Y. (Asst. Program Comm. chairman).

4—Send third copy to Editor, Chemical Engineering Progress, 25 West 45th St., New York 36, N. Y. Paper will automatically be considered for possible publication in A.I.Ch.E Journal.

5—If desired to present paper in a selected symposium, send fourth copy to chairman of the symposium.

6—Prepare five copies of manuscript. Send one copy each to Symposium chairman, Technical Program chairman, or both copies to latter if no symposium is involved. Other three copies should be sent to Editor, C.E.P Presentation at meeting offers no guarantee of acceptance for publication.

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Samples, specifications and detailed information upon request.

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Chemical engineers must have a comprehensive knowledge of current practices.

At the Golden Jubilee Meeting, association with colleagues from all parts of the world will provide opportunities for discussion of mutual problems.

Chemical engineers need a strong and active professional organization.

By attending the Golden Jubilee Meeting, chemical engineers will support and strengthen their organization. The strength of the A.I.Ch.E. is proportional to the participation of its members.

Chemical engineers will be called upon to solve the many complex technological problems of today and tomorrow.

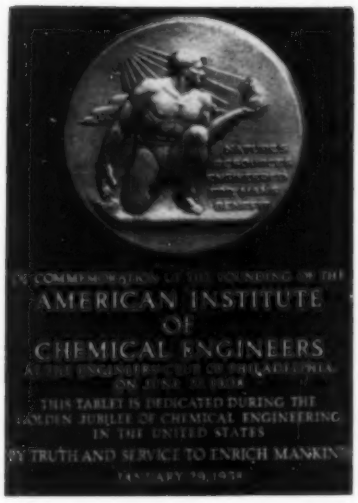
The technical program of the Jubilee Meeting will summarize past accomplishments, point out present deficiencies in chemical technology, and indicate possible approaches toward overcoming these deficiencies.

Therefore: chemical engineers should attend the Golden Jubilee Meeting in Philadelphia in June.

Chemical engineers cannot afford to miss this once-in-a-lifetime opportunity to take part in a most historic event of their Institute.

Q. E. D.

For further information, write to Local Arrangements Committee General Chairman William E. Chalfant, The Atlantic Refining Company, Box 8138, Philadelphia 1, Pa.



JUBILEE KICKOFF!

- **Time: January 29, 1958**
- **Place: Philadelphia Engineer's Club**

PLAQUE DEDICATED

How does one describe an event of last week in a manner that historians fifty years hence will agree conveys its real significance? How much easier it is to be a historian re-working the documents already yellowed, than it is to have shared the company and ceremony of one's contemporaries, and then proceed to write the event into history!

The subject event took place one recent cold night in Philadelphia. Walking the two or three short blocks from the Bellevue Stratford to the Engineer's Club, we wondered what our founders were thinking and talking about, as they walked the same steps one hot night forty nine and a half years ago.

Surprisingly, it wasn't long before we were to find out what (in addition to the organization of the new society) was on the minds of these people. For one of the original founders, Frederick Dannerth—a witty and philosophical gentleman in his seventies—was soon to devote his remarks to the kind of a world that people were living in in 1908. With the added value of the research into past history contained in a talk prepared by Ray Genereaux (but read by J. I. Harper), we found ourselves realizing that the world of 1908 gave people many of the aspirations and subjected them to the tensions which we are always so prone to regard as uniquely ours today. For a picture of what was happening 50 years ago, see the "headlines" below.

WANTED

Old pictures. Do you have old snapshots of significant people and events of the early days of chemical engineering? CEP would like to borrow your best ones for possible use in the May Jubilee Issue. We would need them by April 1; they will receive good care and will be returned.

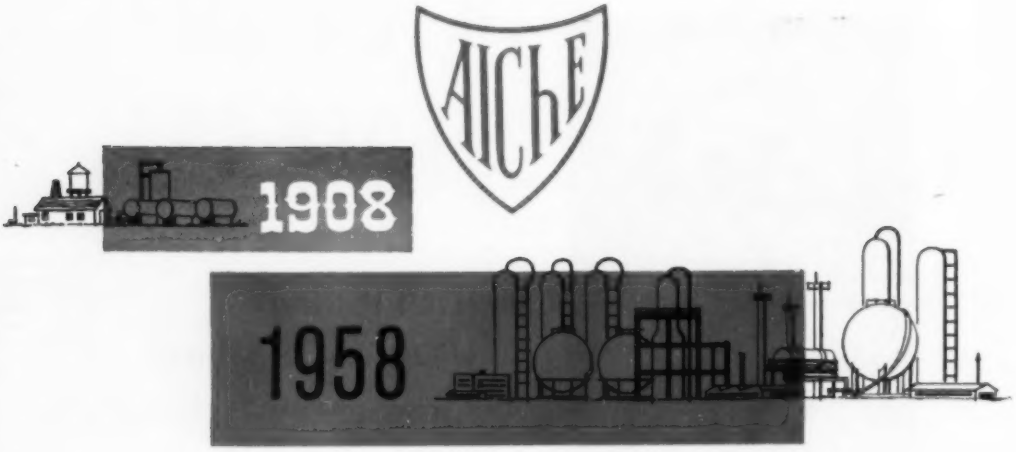
The reason for the meeting of January 29—and we should, of course, add 1958—was to dedicate the plaque which by now probably graces the entranceway of Philadelphia's stately Engineer's Club. In an unveiling ceremony, A.I.Ch.E. president George Holbrook presented the plaque to Club past-president Joseph Grey Jackson, a chemical engineer who practices patent law in the city of Philadelphia. In the picture of the event, below, Mr. Dannerth looks on from behind the plaque.

Consistent with the theme of the forthcoming Jubilee meeting—"A Look to the Future"—President Holbrook favored the audience of members of the Philadelphia-Wilmington Section with a brief report on what is happening within the Institute to provide for its future. And where better to publish such an analysis than in the forthcoming special Jubilee Issue of Chemical Engineering Progress—May 1958!

WHAT WAS DOING IN 1908

- Nobel Prize in physics to Gabriel Lippman for his method of reproducing colors by photography. In chemistry to Rutherford for his studies on the disintegration of chemical elements and radioactive substances.
- Baekeland announces his invention of phenolic plastics.
- Earthquakes in Sicily kill 76,000.
- Rimsky Korsakoff, the Russian composer, dies.
- Milton Berle, Don Ameche, and Bette Davis are born.
- The elements krypton, xenon, neon, polonium, and radium are only ten years old.
- Johnny Hayes of the U.S. wins the Olympic Marathon in 2 hours 55 minutes.
- Ski-jump record in the U.S., held by John Evenson, is 122 feet.
- A currency panic occurred the year before, due largely to the lack of a national banking system.
- Congress passes a bill regulating child labor in the District of Columbia.
- Smoking for women in public places is made illegal in New York City.
- Model T is introduced at $850.
- Steamship fare (steerage), Genoa-New York: $12.
- First Zeppelin aloft for 12 hours.
- Marconi communicates overseas by wireless.
- Forty-seven story Singer building completed.
- Wright brothers in air 38 minutes and cover 24 miles.

Left to right: Holbrook, Dannerth, Jackson.



this GOLDEN ANNIVERSARY is your GOLDEN OPPORTUNITY!

May 1958 CHEMICAL ENGINEERING PROGRESS will be a spectacular issue commemorating the "Chemical Engineers' Golden Jubilee"

The American Institute of Chemical Engineers' 50th Anniversary marks a major milestone in the progress of the Chemical Process Industries, from the celluloid era to today's rocket fuels. From vital discoveries in basic research, through the entire scope of chemical engineering, A.I.Ch.E. will celebrate fifty fabulous years of achievement.

A salute to the past is only part of the celebration. The main theme of the Jubilee program next June at Philadelphia will be "A Look to the Future." Here is the real significance of May CHEMICAL ENGINEERING PROGRESS for all advertisers—chemical engineers dedicated to the growth and development of all chemical industries.

This is truly a *golden opportunity* for manufacturers to instill both their corporate and their product messages in the minds of responsible chemical engineers—men whose decisions are essential to the purchase and specification of practically all chemicals, equipment, materials and engineering services in the chemical process industries.

Highlights of May C.E.P. include a History of Chemical Engineering and A.I.Ch.E., and a survey of Chemical Engineering Around the World, plus other fascinating features and timely engineering articles. This matchless editorial selection insures intensive readership.

Take full advantage of this unusual opportunity to invest in your company's future in the growing C.P.I. Join the many advertisers who are planning special product progress stories to relate their company growth to the Golden Jubilee of A.I.Ch.E.

The May 1958 issue of C.E.P. will be a big issue—your big opportunity to get big results. Be sure to reserve *adequate* space.

CEP CHEMICAL ENGINEERING PROGRESS

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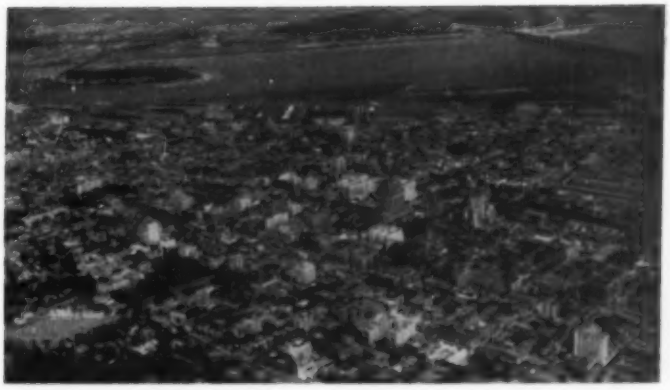
50 FABULOUS YEARS OF ENGINEERING ACHIEVEMENT AIChE



AT MONTREAL: solid fare with that continental touch

Chemical engineers who plan to attend the coming A.I.Ch.E.-C.I.C. Conference in Montreal (April 20-23) will have the opportunity to hear not only some of the top men in their fields in North America but also top level executives of the European chemical industry.

Apart from the U. S.-Canadian contributions to the technical program, a truly international flavor will be added to the proceedings by a three-session review of the European chemical industry given by representatives of the four largest chemical companies on that continent: Imperial Chemical Industries of Great Britain, Etablissements Kuhlmann of France, Farbwerke Hoechst of West Germany, and Montecatini of Italy.

Special interest, in this Sputnik era, attaches to the participation of two Soviet scientists in the panel discussions. They will discuss the chemical industry and chemical engineering education in the Soviet Union—vital factors in the present scientific competition between East and West.

For the chemical engineer and the chemical industry executive directly concerned with finance and investment, a highlight of the conference will be the panel discussion on Relationships Between Investors and Chemical Industry Management.

The technical program is wide and varied: statistics in chemical engineering, chemical engineering in mineral processing, high temperature materials—but see the complete program herewith!

The ladies, of course, have not been forgotten by the program planners. A trip around Montreal, an expedition into the Laurentian Mountains, a fashion show, not to mention special lunches and the gala Habitant dinner and dance on Tuesday, have been arranged for their pleasure and amusement. Come to the Fair!

SUNDAY, APRIL 20

1. PANEL DISCUSSION—CHEMICAL ENGINEERING EDUCATION IN THE U.S. AND CANADA, W. G. Whitman, M.I.T., moderator.
A comparative exploration.
Panelists: J. B. Phillips, McGill Univ.; G. W. Govier, Univ. of Alberta; R. R. McLaughlin, Univ. of Toronto; E. W. Comings, Purdue; W. R. Marshall, Jr., Univ. of Wis.; R. W. Wilhelm, Princeton Univ.

LADIES PROGRAM

Monday—Trip around Montreal, Lunch at St. Helen's Island.
Tuesday—Trip into Laurentian Mountains, Lunch at Chantecler Hotel.
Wednesday—Fashion show in Sheraton Mount Royal Hotel.

MONDAY, APRIL 21

2. THE CHEMICAL INDUSTRY IN EUROPE TODAY, PART 1, Chmn: H. H. Lank, DuPont (Canada).
The Chemical Industry in the United Kingdom, R. Holroyd, I.C.I., London, England.
The Chemical Industry in France, J. J. Desportes, Kuhlmann, Paris, France.

3. STATISTICS IN CHEMICAL ENGINEERING, Chmn: J. C. Whitwell, Princeton.
Statistics in Chemical Experimentation, S. L. Andersen, DuPont.
Response Surfaces in Empirical Experimentation, J. S. Hunter, Princeton.
Least-Squares Fitting of Nonlinear Chemical Engineering Models, D. W. Marquardt, DuPont.
Evolutionary Operation—Optimizing Plant Operations, T. L. Koehler, American Cyanamid.

4. THE CHEMICAL INDUSTRY IN EUROPE TODAY, PART 2 ,Chmn: R. S. Jane, Shawinigan Chemicals Ltd.
The Chemical Industry in Western Germany, Karl Winnacker, Farbwerke Hoechst, Frankfurt, Germany.
The Chemical Industry in Italy, Giulio Natta, Montecatini, Milan, Italy.

5. CHEMICAL ENGINEERING PROBLEMS IN HEAVY WATER REACTORS, Co-chmn: D. Stewart, U.S.A.E.C. and W. M. Campbell, Atomic Energy of Canada.
Natural Versus Enriched Uranium, D. P. Herron, American-Standard.
Heavy Water Production Processes, P. J. Selak and J. Finke, Kaiser Engineers.
Conditioning of D_2O, G. M. Allison, Atomic Energy of Canada.
Procedures for Evaluation of Reactor Fuels and Sheathing Materials, R. F. S. Robertson, Atomic Energy of Canada.
Heat Exchanger Design, A. D. Duff, Jr. and E. E. Wilson, Du Pont.

6. THE CHEMICAL INDUSTRY IN EUROPE TODAY, PART 3, Chmn: J. H. Shipley, Canadian Industries, Ltd.
Speakers: Two members of Soviet Academy of Science, one from Moscow Univ. on **Chemical Education in Russia,** the other on **Soviet Chemical Industry.**

TUESDAY, APRIL 22

7. CHEMICAL ENGINEERING IN MINERAL PROCESSING, Chmn: F. A. Forward, Univ. of British Columbia.
Chemical Engineering in Development of Sherritt Gordon Nickel Refining Operation, M. A. Schoening and D. B. Smith, Sherritt Gordon Mines.
Use of Lead in Chemical and Metallurgical Plant Construction, A. Turner, J. R. Wellington, and L. Williams, Cons. Mining and Smelting of Canada.
Selection and Design of Liquid-Solids Separation Equipment in Hydrometallurgical Leach Circuits, R. C. Emmett and D. A. Dahlstrom, Eimco.
Meeting Future Demands for Uncommon Metals, R. W. Hale and R. J. Lund, Battelle.

8. HIGH TEMPERATURE MATERIALS FOR JETS AND ROCKETS, Chmn: C. J. Marsel, New York Univ.
High-Temperature Environments Associated with Jet Propulsion, F. L. Bagby, A. E. Weller, and B. Steginski, Battelle.
Problems of airframe and propulsion system materials in high-temperature flight.
Plastic Bound Inorganics for High Temperature Construction, J. H. Lux, Haveg Ind.
Combinations of plastics and ceramics to withstand temperatures from 2,000 to 10,000° F.
Polymers for High Temperature Service, W.

(Continued on next page)

Montreal (Continued)

Brenner and C. J. Marsel, New York Univ.
Current work on fluorinated plastomers and elastomers, development of semi-organic and inorganic polymeric structures.

Heat-Resistant Alloys for Temperatures Above 1,000° F., K. B. Young, International Nickel (Canada).
Complex nickel and cobalt-containing alloys.

Titanium—The Newest Structural Metal, W. M. Minkler, Titanium Metals.
General characteristics of titanium and titanium alloys, applications to chemical processing equipment.

9. FLUID MECHANICS, PART 1, Chmn: S. G. Mason, McGill Univ.

Mechanics of Moving Vertical Fluidized Systems: Application to Co-current Countergravity Flow, D. L. Struve, L. Lapidus, and J. C. Elgin, Princeton.
Comparison of experimental data with operating diagram.

Upwards Vertical Flow of Air-Water Mixtures: Effect of Tubing Diameter on Flow Pattern, Holdup, and Pressure Drop, G. W. Govier and W. L. Short, Univ. of Alberta.
Visual observations and measurements of holdup and pressure drop over range of air-water ratios.

Ultimate Velocity of Drops in Stationary Liquid Media, M. Warshay, E. Bogusz, M. Johnson, and R. C. Kitner, III. Inst. of Tech.
Effects of high field viscosity and low interfacial tension.

Flow Characteristics of Model Fibre Suspensions, R. R. Schieck and W. H. Gauvin, McGill Univ. and Pulp and Paper Res. Inst. of Canada.

Some Experiments on Orifice Sprays, W. E. Ranz, Penn. State Univ.

10. PANEL DISCUSSION—RELATIONSHIPS BETWEEN INVESTORS AND CHEMICAL INDUSTRY MANAGEMENT, C. F. Prutton, Food Machinery and Chemical Corp., moderator.
Panelists: R. Woodbridge III, New York Life Ins. Co.; W. H. Bowman, American Cyanamid; G. D. Garrett, Jr., Carbide Chemical Co., Montreal; R. B. McPherson, Du Pont (Canada).

11. FLUID MECHANICS, PART 2, Chmn: W. H. Gauvin, McGill Univ. and Pulp and Paper Inst. of Canada.

Mixing Studies on a Perforated Distillation Plate, A. I. Johnson and J. Marangozis, Univ. of Toronto.

Flow of Compressible Fluids, M. B. Powley, Du Pont (Canada).
Development of compressible flow charts in terms of known downstream conditions, applications to design.

Deformation and Oscillation of Liquid Drops Falling Through Water, K. Ramalingam and W. Licht, Univ. of Cincinnati.
Oscillation frequency and amplitude of drops falling at terminal velocities.

Mixing Efficiency Determinations for Continuous Flow Systems, A. Cholette and L. Cloutier, Laval Univ.

Turbulent Heat Transfer to Newtonian Fluids of High Prandtl Number, W. L. Friend and A. B. Metzner, Univ. of Delaware.

PLANT TOURS

- T-1 Seaway Aerial Tour.
- T-2 Industrial Cellulose Research Ltd.
- T-3 DuPont Co. of Canada.
- T-4 Canadian Petrofina Refinery.
- T-5 Quebec Iron and Titanium Corp. and Canadian Titanium Pigments Ltd.
- T-6 Pulp and Paper Research Institute of Canada.

12. NOISE IN THE CHEMICAL INDUSTRY, Chmn: G. Thiessen, Natl. Res. Council, Ottawa.

Hazards of Noise Exposure, W. Rudmose, South. Methodist Univ.
Summary of relation between noise exposure and hearing loss.

Measurement of Noise, L. S. Goodfriend, Editor, Noise Control.
Use of instruments in noise measurements.

Noise with Your Chemicals?, G. L. Bonvallet, Rysdon Products.
Data on noise sources and noise level in the chemical industry.

Methods of Noise Control, T. F. W. Embleton, Natl. Res. Council, Ottawa.
Use of enclosure and shielding devices.

WEDNESDAY, APRIL 23

13. FUTURE SOURCES OF ENERGY, Chmn: J. W. Hodgins, McMaster Univ.

Global Energy Sources and Their Depletion, C. C. Furnas, Univ. of Buffalo.
Particular emphasis on fossil fuels, solar energy, and nuclear energy.

Research at the University of Wisconsin on Engineering Applications of Solar Energy, J. A. Duffie, W. R. Marshall, Jr., and G. O. G. Lof, Univ. of Wis.
Studies of flat-plate and focusing types of solar collectors, development of small solar power systems.

Canada's Present and Future Reserves and Requirements of Hydrocarbons. J. D. Harvie, Imp. Oil Ltd.
Projections of demand and probable growth of reserves.

Chemical Fuels as High Energy Sources, C. W. Perry, Olin Mathieson.
Technical details and economics of fuel production processes.

Nuclear Power—A Future Source of Energy, W. M. Campbell, Atomic Energy of Canada.
Reactor characteristics, chemical engineering problems remaining to be solved.

14. CHEMICAL ENGINEERING IN THE PULP AND PAPER INDUSTRY, Chmn: L. R. Thiesmeyer, Pulp and Paper Res. Inst. of Canada.

Manufacture of Chemical Cellulose from Wood, M. Wayman, Columbia Cellulose Ltd.
Progress made and problems remaining.

Continuous Chemical Pulping, J. S. Hart, Pulp and Paper Res. Inst. of Canada.
Laboratory work shows that pulping process can be speeded up.

Recent Developments in Manufacture of Chlorine Dioxide, W. H. Rapson, Univ. of Toronto.
Effect of studies on kinetics of formation of chlorine dioxide.

Experimental Investigation of Forces Exerted on Booms and Piers by Floating Pulpwood, R. J. Kennedy, Queen's Univ.
Dimensional analysis of problem, plus hydraulic laboratory experiments and field measurements.

15. GENERAL TECHNICAL PAPERS, PART 1, Chmn: H. G. Donnelly, Wayne State Univ.

High Purity Tonnage Oxygen for the Steel Industry, J. T. Hugill, Air Liquide (Canada).
Details of 100 ton per day oxygen producing unit.

Kinetics of Nitrogen Tetroxide Absorption in Water, M. M. Wendel, Du Pont, and R. L. Pigford, Univ. of Delaware.
An investigation to determine the rate controlling step in the process.

Chemical Equilibrium and Kinetics in the Nitrogen Oxide-Water System, J. J. Carberry, Du Pont.
It is suggested that nitrogen tetroxide is the reacting oxide of nitrogen in the formation of nitric acid.

Characteristics of Gas Pockets in Fluidized Beds, G. Yasui, Lockheed Aircraft, and L. N. Johanson, Univ. of Wash.
Measurements by use of a light-probe technique.

Flow Characteristics in Horizontal Fluidized Solids Transport, Chin-Yung Wen and H. P. Simons, West Va. Univ.
Dense solids-gas systems have been studied by use of glass beads and pulverized coal in horizontal lines.

16. MODERN ENGINEERING CONSTRUCTION TECHNIQUES, Chmn: S. A. Guerrieri, Lummus Co.

Digital Computer Programs in the Chemical Industry, G. R. Trimble, Jr., Computer Usage Co.
Areas of application, including structural calculations, petrochemical calculations, plant efficiency problems.

Models Build More Economical Plants, T. S. Tucker, Fluor Corp.
Use of scale models said to result in faster and firmer decisions.

Techniques in Modern Fabrication, P. O. Leach, Combustion Engineering.
Forming, welding, heat treatment, destructive and non-destructive testing methods.

Modern Construction Methods Reduce Costs, R. W. Hudson, Foster Wheeler.
New techniques in design, erection, and application of equipment.

17. GENERAL TECHNICAL PAPERS, Chmn: K. O. Beatty, Jr., N. Carolina State College.

Operational Control of Continuous Distillation Plant, R. Parkins, I.C.I., London.
Alternative methods and practical examples from large-scale installations.

Extruder Design with a Pseudo-Plastic Fluid, E. S. deHaven, Dow Chemical.
Experimental data are presented to verify the design procedure used.

Heat Transfer by Radiation Through Porous Insulation, B. K. Larkin, Ohio Oil, and S. W. Churchill, Univ. of Mich.
Theoretical and experimental investigation of radiant transfer through fibrous and foamed insulating materials.

Heat Transfer to a Liquid Fluidized Bed, R. Lemlich, Univ. of Cincinnati, and I. Caldas, Antibioticos S.A. (Spain).
Study of the rate of heat transfer from a retaining wall to a fluidized bed of solids.

Combined Laminar Free and Forced Convection Heat Transfer in External Flows, A. Acrivos, Univ. of Calif.
Method for calculating shear stress and rate of heat transfer in external flows for combined laminar forced and free convection.

18. PANEL DISCUSSION—CAREER OPPORTUNITIES IN CHEMICAL ENGINEERING, Chmn: G. T. Page, Engineering Inst. of Canada.
Panelists: H. F. Bartram, Great Lakes Carbon (Montreal); D. M. Riley, Polymer Corp., Sarnia, Ont.; C. M. Cooper, DuPont; J. S. Spriggs, Dow Chemical.

1958 nuclear congress

FOURTH NUCLEAR ENGINEERING & SCIENCE CONFERENCE

With nearly 200 preprints, and engineers attending from Peru to Japan, this year's Conference will be the biggest to date. Here is the program, arranged by subject and time of session for quick reference.

• Commercial Use of Radioactive Tracers

(Mon., March 17, 9:30 A.M.)
Chmn. W. E. Barbour

71 Fungicidal Action Tracer Studies, Greenlee, et al, Battelle.
70 Tracers in Extreme Pressure Lubrication, Loeser, et al, Chrysler.
75 Tracer Leak Location in Multiwalled Tanks, Sullivan, Nat'l Lead.
170 Chromium 51 Plated Rings for Use in Wear Studies, C. H. Wright, U. S. Radium.
171 Radioactive Chromium as a Tracer Aid, R. G. Abowd, Jr., Ethyl; Sullivan, et al, National Lead.

• Reactor Component Development, Fabrication, and Testing

(Mon., March 17, 9:30 A.M.)
Chmn. R. H. Shannon

74 Diaphragm Feed Pumps for Homo. Reactors, Gabbard, ORNL.
76 High Temp. Canned Liquid Metal Pumps, Steele, West.
77 Selection Guide for Canned Pumps, Wepfer, West.
183 Operation of 3000-GPM Sodium Pumps, C. E. Miller, GE.
189 Design of Reactor Piping and Pressure Tubes for PRPR, J. C. Fox, GE.
197 High Pressure Control Rod Actuator, C. Linnert, AMF Atomic.

(Mon., March 17, 2:00 P.M.)
Chmn. C. J. Brous

30 Control Rod Mechanism for Argonne Low Power Reactor, Kann, Argonne.
167 Welded Seal for Reactor Vessel Head, Garner, et al, Combust. Engrg.
80 Control Rod Mechanism for Hermetically Sealed Reactor, Gertz, et al, West.
149 Control Valves for Homo. Reactor Test, Billings, ORNL.
190 Novel Control Rod Actuator for Nuclear Reactors, Scotto, et al, Amer. Bosch Arma.

• Standardization, Codes, and Licensing

(Mon., March 17, 9:30 A.M.)
Chmn. M. C. Leverett

78 Structural Evaluation Procedures, Cooper, Knolls.
79 Design Code Problems, Zickel, G-E.
132 Pressure Piping Inspection and Testing, Malcolm, et al, Chapman Valve.
200 Leak Tightness Inspection of Nuclear Power Plants, D. J. Santeler, GE.

• Reactors for Process Heat and Radiation

(Mon., March 17, 9:30 A.M.)
Chmn. A. Lichtenberger

162 Chlorination of Mesitylene and Naphthalene, Sergy, et al, U. Mich.
48 Radiation Effects on Cellulose and Derivatives, Teszler, et al, N. C. State.
198 Danger Coefficient Analysis vs. Activation Analysis, Gustavson, et al, Aerojet.
180 Reactor Source for Space or Process Heat, W. L. Ross, Amer.-Standard.
181 Market for Industrial Heat Reactors, K. M. Mayer, ACF Industries.

• Production and Miscellaneous Application of Radioisotopes

(Mon., March 17, 2:00 P. M.)
Chmn. P. Aebersold

45 Irradiation Release of Strain in Prince Rupert's Drops, Greene, N.Y. Cer. Coll.
60 Tritium as an Instruments Ionizing Source, Vanderschmidt, et al, Nat'l Res.
135 Density of Sediment by Gamma Scattering, Timblin, Denver Fed. Cntr.
136 Production of Barium-140, Legler, et al, Phillips.
— Recovery of Radioactive Cesium at Hanford, Judson, et al, GE.

• Reactor Operation and Maintenance

(Mon., March 17, 2:00 P. M.)
Chmn. C. Starr

81 Start-Up and Operation of Sodium Reactor Exper., Glasgow, Atom. Int'l.
82 Direct Maintenance for Homo. Reactor Test, Beall, et al, Ohio Pwr.
83 Full Power Testing at Shippingport, Schaffer, Duquesne.
192 Early Operating, Maintenance Experience With APPR, Barnett, et al, Army Engineers R&D.
184 Cleaning Nuclear Reactor Systems, Medin, et al, ALCO.

(Tues., March 18, 9:00 A. M.)
Chmn. C. R. Braun

68 Army Package Power Reactor, Medin et al, Alco.
88 Proposed Fuel Handling Facilities, Bellarts, G-E.
89 Nuclear Operator Training, Enstice, et al, West.
90 Planning for the Startup of the Dresden Nuclear Power Station, Perkins, et al, G-E.
92 Long-Lived Circulating Activity at APRR-1, Small, Alco.
130 Water Treatment Process for the Dresden Nuclear Power Station, Ongman, G-E.

• Fuel, Control, Moderator and Coolant Materials

(Mon., March 17, 2:00 P. M.)
Chmn. R. W. Dayton

13 Active vs. Inactive UO_2-O_2 System, Vaughan, Battelle.
18 Pile-Irradiation effects on U_3Si, Bleiberg, et al, West.
23 Radiolytic and Pyrolytic Decomp. of Organic Coolants, de Halas, G-E.
20 Organic Coolant in a Heavy Water Reactor, McNelly, G-E.
65 Prep. and Prop. of UO_2 Powder, Harrington, et al, Mallinckrodt.
182 Process for Improving Chemical Characteristics of Uranium Oxides, W. R. De Hollander, GE.
193 Zirconium-Uranium Dioxide Reaction, A. F. Gerds, et al, Battelle.

(Tues., March 18, 9:00 A. M.)
Chmn. D. E. Thomas

17 Transformation Cooling Rate Effects on Recrystallization of Beta Quenched U, Gardner, et al, G-E.
85 Carbon Effect on Transformation of U-Nb Alloys, Maier, et al, West.
63 Electron Metallography of U-Ni Diffusion Zones, Angerman, DuPont.
84 Corrosion of U-Zn Alloys in High Temp. Water and Steam, Kass, et al, West.
86 Corrosion of U-Nb Alloys ir High-Temp. Water, Chirigos, et al, West.
172 Kinetics of Beta Transformation of Uranium, W. R. McDonnell, Du Pont.
178 Dimensionally Stable Uranium Alloys, Eiss, et al, Sylvania-Corning.

(Wed., March 19, 9:00 A. M.)
Chmn. A. R. Kaufmann

16 Cement Control Rod Fabric by Powder Rolling, Storchheim, Metals Res. & Dev.
2 Blending vs. Re-Enrichment for Slightly Enriched U, Kallman, et al, B&W.
43 LMFR Breeder Blanket by Fusion Electrolysis, Sibert, et al, Horizons, Inc.
62 Silver Base Alloy for Control Use in Nuclear Reactors, Haffeman, et al, West.
104 Dispersed Boron Control Rods, Paprocki, et al, Battelle.
19 Design and Properties of Alloys for PWR Control Rods, Cohen, et al, West.
31 Aluminum-Uranium Alloys Containing up to 45 w/o Uranium, Daniel, et al, Battelle.

• Aircraft Nuclear Propulsion Concepts

(Tues., March 18, 9:00 A. M.)
Chmn. W. K. Davis

93 Direct Cycle Reactors for ANP, Szekely, G-E.
97 Nuclear Design of Aircraft Reactors, Selengut, G-E.
124 Full-Scale Turbojet Activation Exper., Moteff, G-E.
111 Aircraft Nuclear Reactors Controls, Gorker, G-E.
120 Aircraft Nuclear Reactor Shielding, Aschenbrenner, G-E.

• Health Physics and Instrumentation

(Tues., March 18, 9:00 A. M.)
Chmn. R. F. Shea

4 Application of Pulse Height Analysis to

Health Physics Problems, Carlson, et al, DuPont.

49 Trends in Radiation Protection with Nuclear Reactors, Truran, G-E.

94 Recent Developments in Personnel Radiation Dosimetry, Fitzgerald, et al, G-E.

3 Fission Product Monitors, Kohl, Tracerlab, Inc.

195 Detection of Burst Fuel Elements in Nuclear Reactors, D. Taylor.

199 Induced Photoconductivity in Cadmium Sulfate for Nuclear Radiation Detection, L. E. Hollander, Jr., Amer.-Stand.

• Reactor Physics

(Tues., March 18, 2:00 P. M.)

Chmn. S. Krasik

51 A Magnetic Beam Focusing and Analyzing System for Cyclotrons, Boring, et al, G-E.

95 The Role of Accelerators in Reactor Research, Burrill, Hi Volt.

96 Nuclear Physics and Core Design for the Merchant Ship Reactor, Wood, B&W.

125 Problems with Plutonium Recycle and Exper. Reactor, Tripplett, G-E.

126 Reactor for the Irradiation of Bulky Materials and Equipment, Fischer, et al, G-E.

• Experimental Power Reactors and Advanced Concepts

(Tues., March 18, 2:00 P. M.)

Chmn. L. H. Roddis, Jr.

33 Control System on a Turbine-Generator Supplying Commercial Power as a Nuclear By-Product, Bassett, et al, Knolls.

98 Natural Circulation Boiling Reactors, Flinn, et al, Argonne.

99 Evaporatively Cooled Reactor, Leppert, et al, Stanford U.

100 Armour Dust Fueled Reactor, Krucoff, Armour Res.

176 Role of Experimental Reactor in Plutonium Recycle Program, R. M. Fryar, GE.

201 Preliminary Reactor Design for Liquid Metal Fuel Reactor Experiment, J. J. Happell, Babcock & Wilcox.

Sodium-Cooled, Deuterium-Moderated Reactor, Goldmann, et al,

• Temperature Measurements and High Temperature Instrumentation

(Tues., March 18, 2:00 P. M.)

Chmn. D. I. Cooper

56 High-Temp. Fission Chamber, Ruble, et al, ORNL.

123 High Temperature Neutron Detector, Sehr, Knolls.

151 Temp. Meas. in French Reactors, Weill, Reactor Controls Grp., France.

157 High Temperature Pressure Meas., Ingham, et al, Manning.

159 Thermocouples to Establish Accuracy of Temp. Meas. to 2000° F., Potts, Un. Carb. Nucl.

5 Instrumentation for 2000 lb./sq.in. 600° F. Slurry Test Loops, Goldsmith, (West.) and Wentzel, Penn. P&L.

• Waste Treatment and Disposal

(Tues., March 18, 2:00 P. M.)

Chmn. H. B. Gotaas

141 Radioactive Wastes—European Practice, Straub, Taft.

44 Reactor Fuel Process Wastes, Blomeke, et al, Un. Carb. Nucl.

1 Savannah River Wastes, Manowitz, et al, Brookhaven.

102 Waste Disposal From Dresden Station, Falk, G-E.

40 Uranium Refinery Waste Effect on Receiving Waters, Tsivoglou, et al, U.S. Pub. Health.

185 Tracer Studies on Tidal Estuary Models, Huiswaard, et al, Northwestern.

(Wed., March 19, 2.00 P. M.)

Chmn. H. B. Gotaas

55 Treatment of Wastes Using Ion Transfer Membranes, Mason, et al, MIT.

67 Ruthenium in Fixation of Fission Products, Erlebach, et al, Canad. AEC.

14 Ground Containment and Wastes Control at Hanford, Brown, et al, G-E.

191 Movement of Various Radioactive Isotopes Through Tuff Local to Los Alamos, Christenson, et al, U. of Cal.

196 Effect of P^{32} and I^{131} Wastes on Sludge Digestion, W. N. Grune, Ga. Tech.

• Reactor Plant Instrumentation

(Wed., March 19, 9:00 A.M.)

Chmn. H. A. Lamonds

6 Meas. of Primary Water Flow, Collins, Knolls.

36 Feedwater Control System for EBWR, Morse, et al, L&N.

34 Meas. of Gases in High Pressure Water Reactor Plants, Steiner, G-E.

103 Control for Boiling Water Reactors, Brey, L&N.

163 Steam Generator Instrumentation for Power Plant with Analog Computer Verification, Lynch, et al., G-E.

174 Main Coolant Instrumentation for High Performance Pressurized Water Reactor Power Plants, L. C. Noyes, GE.

• Reactor Location and Safety

(Wed., March 19, 9:00 A.M.)

Chmn. C. R. McCullough

15 Gainesville, Florida, Area Factors Affecting Location of Research Reactor, Reichert, U. of Florida.

46 Pu Recycle Reactor Hazards, Wittenbrock, G-E.

106 Health Physics for Urban Facility, Baum, Armour Res. Fdtn.

148 Design of Nuclear Lab, Weinberg, Astra, Inc.

• Thermal and Mechanical Design

(Wed., March 19, 9:00 A. M.)

Chmn. N. J. Palladino

107 Core Thermal Design of Army Package Reactor LA, Brondel, Alco.

108 Electrolytic Analog for Reactor H.T. Problems, Anthony, et al, Nucl. Dev. Corp.

145 H.T. of Polyphenyl Coolants, Silberberg, et al, Atomics Intl.

179 Steady State Performance of a Thermal Circulation Loop Containing a Parallel Path Heat Sink, J. J. Foster, GE.

202 Internal Hydraulic Effects from Mechanical Shock of Reactor Vessel, Weinstein, et al, Carnegie.

(Wed., March 19, 2:00 P. M.)

Chmn. O. E. Dwyer

27 Free Convec. H.T. to Water and Hg in an Enclosed Cyl. Tube, Hartnett, et al, G-E.

144 Effect of Volume Heat Source on Free Convec. H.T., Randall, et al, Purdue U.

146 Boiling Press. Drop in Thin Rect. Channels, Sher, et al, West.

147 2-Phase Steam-Water Press. Drops, Isbin, et al, U. Minn.

• Reactor Control Instrumentation

(Wed., March 19, 2:00 P. M.)

Chmn. J. Harrer

42 Design of Safety System for Fermi Power Plant, Underkoffler, et al, At. Pwr. Div.

32 Instrumentation for Boiling Water Reactor, Kornblith, G-E.

53 Power Plant Transfer Functions, Smets, et al, MIT.

50 Modules in Reactor Control Instrumentation, Cockrell, et al, L&N.

152 French Control Instrumentation, Weill, Reactor Controls Grp., France.

175 Reactor Power Calculator, J. W. Adams, Du Pont.

• Progress in Commercial Power Reactor Development

(Mon., March 17, 8:00 P. M.)

Chmn. C. H. Weaver

127 Commercial Power Plants Devel., Farbman, West.

131 Con. Edison Generating Station, Hanson, et al, B&W.

— Progress in Design of Yankee Atomic Plant, Reed, et al,

(Thurs. March 20, 9:00 A. M.)

Chmn. C. H. Weaver

69 Power for First Nuclear Merchant Ship, Whitelaw, B&W.

— Controlled Recirculation Boiling Water Reactor Project, R. M. Casper, et al.

• Reactor Plant Materials

(Wed., March 19, 2:00 P. M.)

Chmn. M. A. Cordovi

24 Corrosion Screening of Materials for NaK Heat Exchange, Basham, et al, Battelle.

109 Corrosion Tests of Materials in Irradiated Organics, Kline, North Amer.

37 Radiation Damage of 7 Non-Fissionable Metals, Bruch, et al, G-E.

188 Engineering Approaches to Materials Problems of Nuclear Power Plants, Fleischmann, et al, GE.

194 Corrosion Studies in Organic Heat Exchange Media, Boyd, et al, Battelle.

• Water Contamination and Treatment

(Thurs., March 20, 9:00 A. M.)

Chmn. M. A. Schultz

10 Radioactivity in Chicago Water Supply, Vaughn, et al, Dept. of Water.

142 Coagulation Removal of Fallout Radioactivity in Waters, Setter, et al, Taft.

143 Gamma Spectrometer for Radionuclides in Water, Hagee, et al, Taft.

169 Methods for Determination of Radionuclides in Water in Low Concentrations, Kahn, et al, ORNL.

(Fri. March 21, 9:00 A. M.)

Chmn. H. H. Gerstein

11 Adsorption of Radioactive Substances on Waterborne and Consol. Mtrls., Barker, U.S. Geol. Surv.

47 Cross Connections: Their Prevention and Control at Y-12, Angele, U.C. Nuclear.

64 Movement of Radioactive Cations Underground, Ewing, U. Calif.

72 Radionuclides in Cooling Water, Moeller, (Taft), others, ORNL.

• Chemical Reprocessing

(Thurs., March 20, 9:00 A. M.)

Chmn. C. C. Woolsey

26 Auxiliary Equipment, Unger, ORNL.

28 Flow Generation, Measurement, and Control, Dunn, et al, G-E.

160 On-Stream Alpha Monitor, Hildreth, G-E.

161 Continuous Analyzers in Pilot Plant, Pleasance, G-E.

(Fri., March 21, 9:00 A. M.)

Chmn. S. Lawroski

7 Homo. Reactor Test Chem. Proc. Plant, Burch, U.C. Nuclear.

22 Economics of Reprocessing Using Solvent Extraction, Culler, ORNL.

66 Cost for Fuel from a Single-Region Aqueous Homo. Reactor, Jealous, et al, U.C. Nuclear.

122 Thorex Short Cooled Processing, Meservey.

168 Kinetic Effects in the Partitioning of Uranium and Plutonium in Processing Irradiated Fuels, Morgan, et al, Chalk River.

(Fri., March 21, 2:00 P. M.)

Chmn. C. E. Stevenson

8 Nitrate Complexes Tetravalent Pu, Brothers, et al, Can. AEC.

21 Pilot Plant Fluorination of U Fuel Elements by BrF_3, Strickland, et al, Brookhaven.

39 Disassembly of Spent Reactor Fuels, Barton, et al, AMF.

139 Reprocessing U-Zn Alloy Reactor Fuel Elements, Leak, et al, Phillips.
25 Geometrical Shape and Contin. Dissolution of Al in Hg—Catalyzed HNO_3, Boeglin, et al, Phillips.

• Nuclear Education and Training

(Thurs., March 20, 9:00 A. M.)
Chmn. M. A. Schultz

164 University-Industry Relationships, Murphy, Ia. State.
165 Industry-Government Relations, Davis, AEC.
166 Training for Industry Personnel, Harris, AIF.

• Fuel Element Development, Fabrication, and Testing

(Thurs., March 20, 9:00 A. M.)
Chmn. C. C. McBride

38 Fabr. of S.S.-UO_2 Fuel Plates, Weinberger, et al, Sylvania-Corning.
114 Gas Pressure Bonding of Assemblies, Paprocki, Battelle.
115 Forge Rolling Element and Cover Plates, Johnson, et al, Clevite.
173 Development of Wafer-Type Fuel Element for EBR II, Megeff, et al, Syl.-Corn.

(Thurs., March 20, 2:00 P. M.)
Chmn. J. E. Cunningham

116 Fuel Irradiation Test Facilities, Schlitz, et al, Argonne.
129 Model Studies of Element Flow Characteristics for Fermi Reactor, McDaniel, et al, U. Mich.
140 Feasibility of Tracer System for Locating Element Failure in PWR, Pobereskin, et al, Battelle.
133 High Temp. Fatigue Testing of U, Bohn, et al, Ia. State.

• Reactor Safety and Start-up Instrumentation

(Thurs., March 20, 3:00 P. M.)
Chmn. J. I. Dever

41 Variation of Trip Point in ORNL Type Safety System, Cockrell, et al, L&N.
35 Transistor Count Rate Systems, Weisner, DuPont.
154 Radiation Damage to BF_3 Proportional Counters, Wilson, West.
156 Counting Channel Pulse Transmission Circuit, Parnell, Mpls.-Honeywell.

• Reactor Systems Analysis

(Thurs., March 20, 2:00 P.M.)
Chmn. J. N. Grace

58 Root-Locus Analysis of Reactor Systems, Lemon, Bendix.
59 Signal-Flow Graphs in Kinetic Analysis of Reactors, Van Rennes, Bendix.
54 Digital Evaluation of Transients for Power Plant Design, Scheib, et al, Knolls.
112 Variable Transport Lag Simulation, Holzmann.
138 Control of PRPR—Gas Balance with Mechanical Supplement, Fletcher, G-E.
153 Techniques in Power Plant Simulation, Weill, Reactor Controls Group, France.

(Fri., March 21, 9:00 A. M.)
Chmn. J. A. Lane

128 Model Coolant Flow Studies in PWR, Grochowski, et al, West.
137 Coolant Temperature Rise in PWR During a Loss of Flow Incident, Weisman, et al, West.
150 Power Driven Rod Insertion, Stell, et al, West.
177 Two Thermodynamic Systems for Molten Fluoride Reactors, Kinyon, et al, ORNL.
186 Steady-State Part-Load Characteristics of a Sodium-Heated Steam Plant, W. T. Morgan, et al, Atom Int.

• Research and Test Reactors and Critical Assemblies

(Thurs., March 20, 2:00 P. M.)
Chmn. R. L. Doan

29 Safety in Handling and Storage of Fuels, Ketzlach, G-E.
57 Design of Enriched U Neutron Flux Converter, Anliot, et al, Admiral.
117 Mechanical Design of SPERT Reactors, Wilson, et al, Phillips.
118 High Power Intermediate Enrichment Pool Reactor, Jacobson, et al, G-E.
A Materials and Engineering Test Reactor for Belgium, A. Flynn, et al.
187 GE Test Reactor Plant and Facilities, Craig, et al, GE.

• Reactor Shielding and Containment

(Fri., March 21, 9:00 A. M.)
Chmn. H. L. Bowman

9 Thermal Design Considerations of Concrete Shields, Davis, G-E.
61 Civil Engineering Aspects of Dresden Power Station, Love, et al, G-E, others, Bechtel.
119 Reactor Shield Calculations, Edwards, G-E.
73 ERB-II Primary Tank Support Structure, Seidensticker, et al, Argonne.
121 Containment-Vessel Design for Dresden Power Station, Sege, G-E.

SIXTH HOT LABORATORIES & EQUIPMENT CONFERENCE

Organized by the Hot Laboratory Committee, this conference will again this year go into detailed analysis and discussion of the operation and equipment of "hot" facilities. Symposia and papers to be presented are as follows:

Wed., March 19, 9:00 A.M.

Hot Cells and Process Facilities: PAPERS—New Multi-Cell Facility in Idaho; Modified Hot Cell Facility at Livermore, Cal.; Remote Metallography; Hot Machine Shop Cell; Segmenting Cells for Dismantling; New Chemistry Cell & Hot Waste Disposal System at Knolls; Design for Remotely Operated Facility for High-Temp. Processing of Spent Fuel; Equipment for Purification of Spent Fuel by Melt Refining; Shielding Window Design for ERB-II Process Plant; Analytical Junior Cave Facility for ERB-II.

Wed., March 19, 2:00 P.M.

European Hot Laboratories: PAPERS—10 Kilocurie Hot Lab in Saclay; Equipment and Radio-Chemical Techniques at Saclay; Equipment and Radio-Metallurgical Techniques at Saclay; C.E.N.'s Hot Facilities at MOL.

Thurs., March 20, 9:00 A.M.

Irradiation and Other Facilities: PAPERS—U. of Minn. Gamma Irradiation Facility; A 19.5 Kilocurie Co-60 Source and Hot Cell; Radiation in the Petroleum Industry; Construction, Start-up of 100,000 Curie Co-60 Irradiation Facility; Survey of Characteristics of Gamma Irradiation Facilities; Design of Idaho Extended Core Facility; Reactor Core and Fuel Element Handling & Disassembly in the ECF Water Pits; Experience with Zinc Bromide Shielding Windows at Knolls; Remotely Cutting and Canning Core Samples from Underground Nuclear Tests; Portable Shielded Vehicle.

Hot Laboratory Practices and Equipment: PAPERS—Remote Metallography Practices at Battelle's Hot-Cell; Remote Metallographic Equipment and Practices; Micromanipulator for Use Inside a Remote Handling Cell; Impression Molding of Radioactive Elements; Density Measurement Problems in Hot Cells; Primary "Containment" for High Level Cave Experiments; Problems in Isolating Gram Quantities of Transplutonium Elements; Lab Equipment for the Collection of Fission Product Gases from Irradiated Ceramic Fuel Elements; Modifications to Master-Slaves at Bettis Hot Lab; Remote Installation and Removal of Hot Cell Apparatus; Fuel Recovery from Core Meltdown of ERB-II—Mark II (a film).

Thurs., March 20, 2:00 P.M.

The Operational Aspects of Hot Laboratories: A panel discussion by experts from Savannah River, Argonne, Westinghouse, Knolls, Oak Ridge, and Hanford.

Fri., March 21, 9:00 A.M.

Hot Laboratory Safety: PAPERS—Fire Protection and Safety Considerations for Hot Labs; Fire Protection in Radio Chemical Facilities; Hot Lab Safety; Some Safety Recommendations; Laboratory Ventilation; Review of High Efficiency Air Filters.

ATOMIC ENERGY MANAGEMENT CONFERENCE

National Industrial Conference Board again will sponsor this meeting dealing with the management aspects of the growing nuclear industry. Symposia on the following subjects are planned:

Mon., March 17, 9:00 A.M.

- **Health and Safety**
- **Industry Assessment of U.S. Power Reactor Program**
- **Selling Nuclear Products Outside the U.S.**
- **Are Small Reactor Units Economically Feasible?**

Mon., March 17, 2:00 P.M.

- **Power Reactor Experience**
- **Should the Atomic Energy Act be Amended?**
- **Outlook for Nuclear Ship Propulsion**
- **Market Potential for Atomic Materials Outside the Nuclear Field**

Tues., March 18, 9:00 A.M.

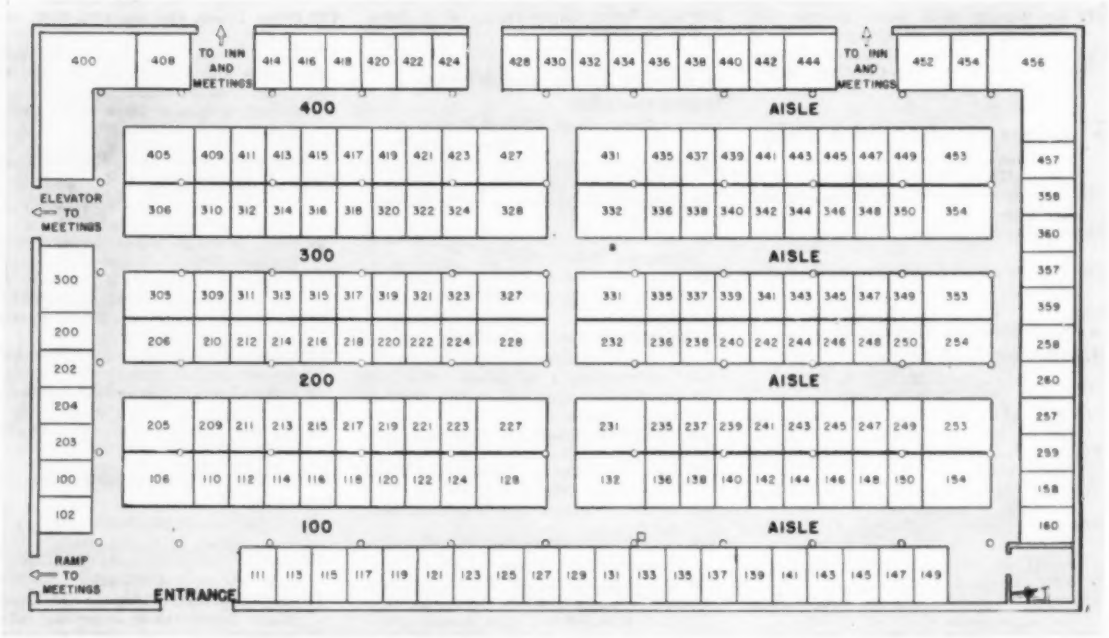
- **How to Develop Better Products Through Radioisotopes**
- **Reduction of Nuclear Power Costs**
- **Materials Testing Facilities—Supply and Demand**
- **How the Indemnification Law is Working**

Tues., March 18, 2:00 P.M.

- **Latest Prospects for Economic Nuclear Power**
- **Potential Applications for Large Sources of Radiation**
- **Latest Developments in Thermonuclear Research**
- **Economics of the Reactor Fuel Cycle**

Wed., March 19, 9:00 A.M.

- **Current Outlook for Nuclear Energy Outside the U.S.**



1958 ATOM FAIR

The newest developments of American industry in the atomic field will be on display at Chicago's International Amphitheatre, March 17-21. Here is *CEP*'s guide to products and services to be shown to the thousands of scientists and engineers attending this Fourth Nuclear Congress. Names of exhibitors are given below, together with booth numbers (see floor plan above) and products.

ATOMIC EXHIBITORS

ACF Industries, Inc. (100, 102). Reactors and nuclear products.

Aerojet General, Inc. (418-420). Mass-produced lab reactors.

Alco Products, Inc. (323, 327). Pressurized water reactor systems.

American Assoc. for Advancement of Science (414). Activities and publications.

Assembly Products, Inc. (228). Process control instruments.

Atnu Engineering Co. (324) R & D consulting services for nuclear problems.

Atomic Development Mutual Fund, Inc. (311). Mutual fund material.

Atomic Energy of Canada, Ltd. (401). Irradiators, radiography machine.

Atomic Industrial Forum, Inc. (147-149). Association material.

Atom Industry (148) Publication.

Automatic Switch Co. (349, 353). Nuclear process valves, switches.

The Babcock & Wilcox Co. (219, 221, 223). Nuclear reactors and fuel elements.

Baird-Atomic, Inc. (210, 212). Instruments for detection, analysis of radioactivity.

Barnstead Still and Demineralizer Co. (145). Equip. for ultra-pure water production.

Bendix Aviation Corp., Cincinnati Div. (150). Nuclear instruments.

The Beryllium Corp. (320). Beryllium metal, chemicals and alloys.

BJ Electronics, Borg-Warner Corp. (154). Nuclear instrumentation.

S. Blickman, Inc. (232). Equipment for safe handling of nuclear materials.

The Brush Beryllium Co. (444). Beryllium metal, fabricated shapes, oxide shapes.

The Budd Company (419-421). Custom radiation facilities.

Bureau of National Affairs, Inc. (135). Atomic Industry Reporter.

Cambridge Filter Corp. (411). Filters, smoke demonstrator.

Carborundum Metals Co., Div. of The Carborundum Co. (447, 449). Zirconium.

Carpenter Steel Co. (114). Stainless pipe and tubing, high alloys, new product.

Central Research Laboratories, Inc. (328). Master-slave manipulators.

Charleston Rubber Co. (238). Neoprene and synthetic rubber clothing.

Cleveland Hard Facing, Inc. (123). Hard faced steel valves, sleeves, etc.

Columbia-National Corp. (427). Zirconium.

Combustion Engineering, Inc. (313, 315). Cores, heavy components, steam generators.

Cooper Alloy Corp. (309). Stainless steel valves and fittings.

Cooper Metallurgical Associates (452). Boron and borides.

Corning Glass Works (202, 204). All-glass equipment, pipes, etc.

Crane Co. (249, 253). Specialized piping products for nuclear industry.

Crawford Fitting Co. (243, 245). Tube fittings.

Crossroads Marine Disposal Corp. (424). Nuclear waste disposal.

Cuno Engineering Corp. (205). All types of filters.

Curtiss Wright Corp. (139, 141) Nuclear reactors, controls, tubing.

Edlow Lead Co. (236). Disposal containers, shielding, shipping casks.

Edward Valves, Inc. (217). Valves.

Encyclopedia Britannica (129). New edition, research services.

Engelhard Industries, Inc. (213, 215). Gas purifying equipment, fuel element components.

Ford Instrument Co., Div. of Sperry Rand Corp. (319, 321). Nuclear control equipment, gas-cooled reactor.

General Atomic Division (340, 342, 439, 441). Research reactor designs, fuel elements.

General Electric Co. (405, 409). Working models of reactor equipment.

Griscom-Russell Co. (305). Models of Liquid Metal Heated Steam Generator, other heat transfer equipment.

Hamner Electronics Co. (224). Electronic instruments.

High Voltage Engineering Corp. (227). Particle accelerators.

Industrial Accessories Corp. (415). Special windows, nuclear fixtures.

International Nickel Co. (113, 115). Nickel, nickel alloys in nuclear use.

O. G. Kelley & Co. (220, 222). Stainless steel equipment and shielding.

Knapp Mills, Inc. (247). Lead products.

Kollmorgen Optical Corp. (246, 248). Optical equipment in nuclear use.

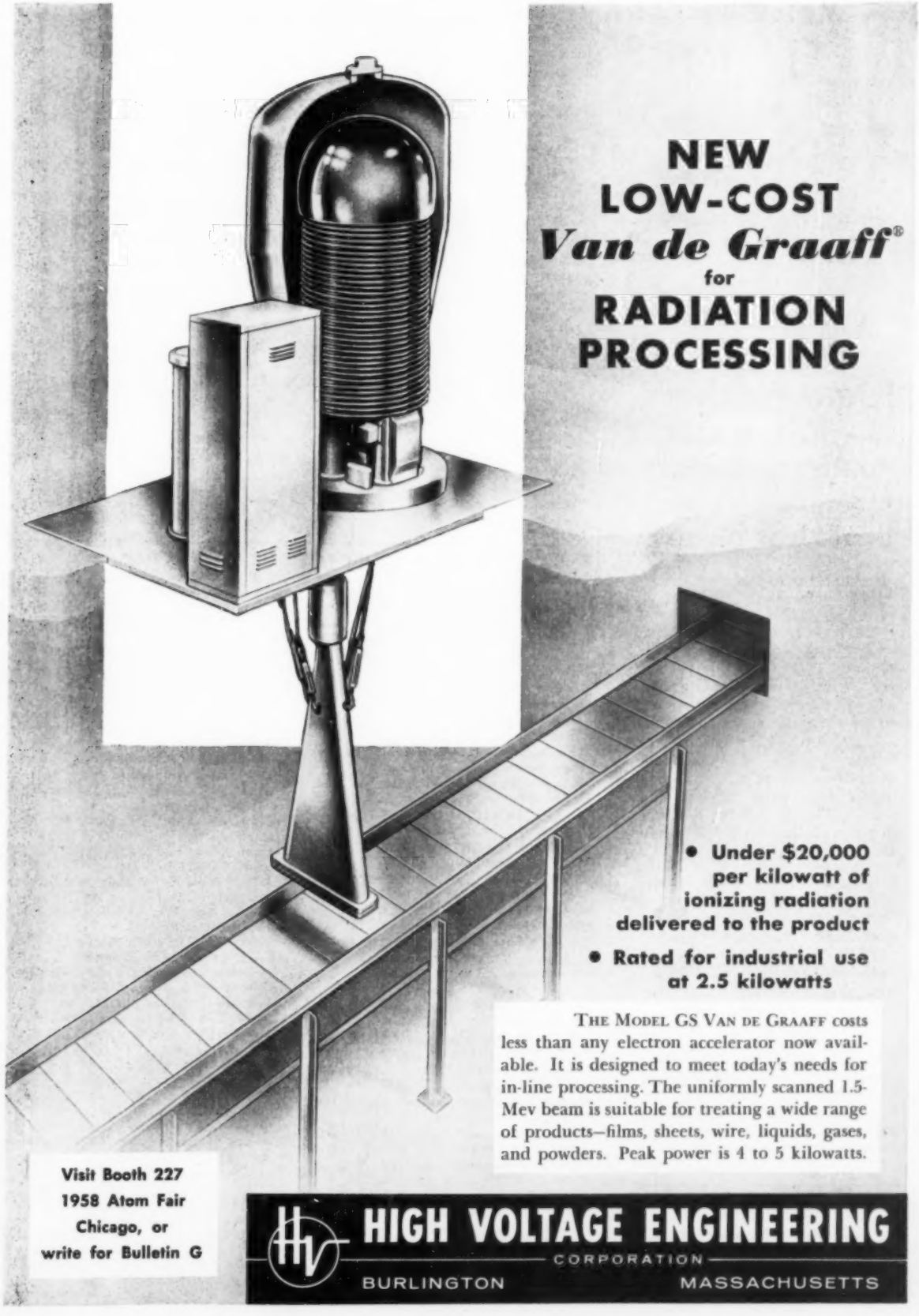
Ladish Co. (138, 140). Fittings, valves.

Leeds & Northrup Co. (209, 211). Package controls for nuclear systems.

P. M. Lennard Co. (111). Dry boxes, safety control equipment, other accessories.

Linde Co. (332, 336, 338). Nuclear graphite and carbon, rare gases.

(Continued on page 192)



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Knight Fume Washers can be built to handle gases or fumes of nearly every character. The one above is removing nitric-hydrofluoric acid fumes which come off pickling tanks that are processing stainless steel tubes. The fumes enter the washer where they are neutralized with a 10% caustic soda solution. Berl Saddle packing, the operating heart of the tower, provides large liquid film areas in the gas stream. This makes for efficient fume washing with relatively small sized equipment.

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PANEL DISCUSSIONS CONSIDER:

- **chemical engineering education**
- **what management expects of Ch.E.'s**

Engineering education should be maintained "tough"; knowledge of the basic sciences should be emphasized; and the "systems" approach will probably increase in importance with time.

These general conclusions were reached during a panel discussion on chemical engineering education at the **Maryland Section** (*P. Messina*) January meeting moderated by H. Hoelscher of Johns Hopkins' Chem. Eng. Dept. The four major subdivisions considered were:

- the standard curricula,
- standard curricula with a "co-op" program,
- engineering science approach with an emphasis on analytical development,
- unified approach, which eliminates departmentalized engineering divisions.

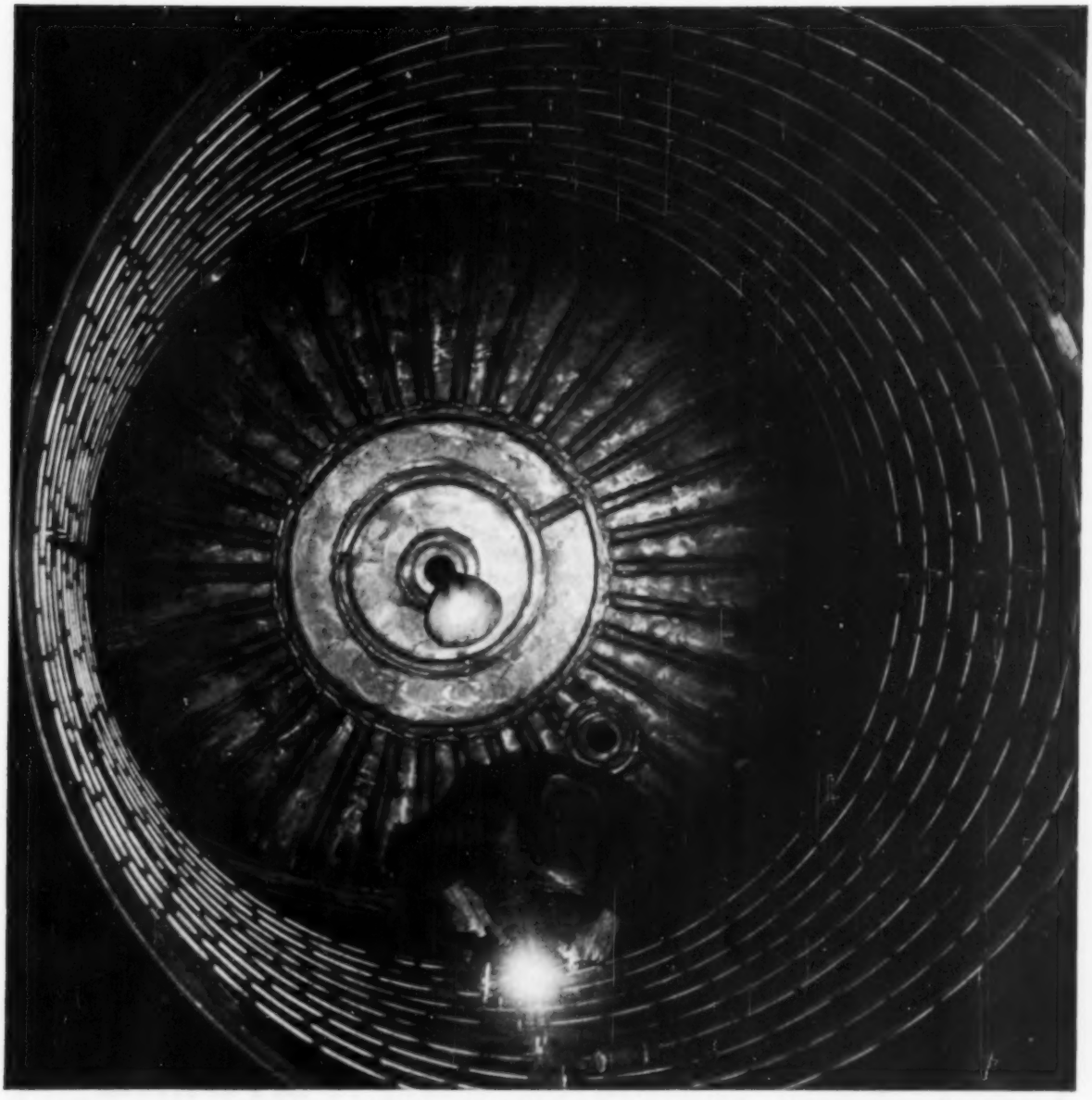
J. Nicholas of Glidden held that the standard curricula was satisfactory for production or pilot plant engineers, but that an "engineering-science" type of approach was desirable for research engineers. R. H. F. Dade of Food Machinery & Chemical Corp. evaluated the educational requirements for an engineer entering a managerial position. He felt that such an individual should have a good basic education without undue specialization. J. M. Mosley of Johns Hopkins made

(*Continued on page* 194)

1958 ATOM FAIR EXHIBITORS

(*Continued from page* 190)

Lindsay Chemical Co. (120). Thorium and rare earth chemicals.
Mallinckrodt Chemical Works (300). Chemicals for nuclear industry.
Mallory-Sharon Metals Corp. (119, 121). Titanium, zirconium, hafnium products.
Marchant Calculators, Inc. (214). Adding and calculating machines.
The Martin Co. (354). Nuclear components, fuel elements.
Massachusetts Dept. of Commerce (432) Mass. for nuclear plants.
Mechanical Div. of General Mills, Inc. (254). Remote controlled handling equip.
George T. Meillon, Inc. (250). PTW dosimeters, film badges, monitometers.
Metals and Controls Corp. (128). Fuel elements and component parts.
Minneapolis-Honeywell Reg. Co. (306, 310). Reactor simulator, electronic equipment.
MSA Research Corp. (335, 337). Pumps, gauges, meters, special alloys, etc.
National Carbon Co. (332, 336, 338). Nuclear graphite and carbon, rare gases.
National Lead Co. (431). Shielding, nuclear fuel elements.
Neutronics Laboratory (112). Reactor control instruments.
North American Aviation, Inc. (116, 118). Power reactor models.
Nuclear-Chicago Corp. (341, 343). Training reactor, lab equipment.
Nuclear Development Corp. of America (345, 347). Large reactor model.
Nuclear Measurements Corp. (122). Radiation detection instruments.
Nucleonics, McGraw-Hill Pub. Co. (110). Nucleonics and Electronics magazines.
Penberthy Instrument Co. (428). Radiation shielded viewing windows.
Pergamon Press, Inc. (124). Technical and scientific publications.
Plan Hold Corp. (216). Filing equipment.
Purolator Products, Inc. (136). Filters, diffusers, separators.
Radiation Counter Labs., Inc. (331). Nuclear data processing instrumentation.
Radiation Instrument Dev. Lab. (445). Nuclear instrumentation.
Saginaw Steering Gear Div., GMC (322). Ball bearing screws and splines.
Sandusky Foundry & Machine Co. (453). Centrifugally cast cylinders, piping.
Superior Steel Div., Copperweld Steel Co. (317). Shapes in boron stainless, zirconium and alloys.
Superior Tube Co. (312). Small diameter metal tubing, control rods, etc.
Sylvania-Corning Nuclear Corp. (106). Nuclear fuel elements.
Technical Associates (142). Instruments, monitors, shields.
Thermal Refractories Corp. (318). Beryllia, alumina, thoria, spinel, etc.
Thompson Products, Inc. (357, 360). Nuclear energy components.
Tracerlab, Inc. (422). Monitors, associated electronic equipment.
Union Carbide Corp. (332, 336, 338). Nuclear graphite, carbon, and rare gases.
Union Carbide Nuclear Co. (332, 336, 338). Nuclear graphite, carbon, and rare gases.
United Shoe Machinery Corp. (239, 241). PWR refueling system, other equipment.
United States Radium Corp. (339). Radiation sources.
United States Steel Corp. (240, 242, 244). Alloy and stainless steel equipment.
D. Van Nostrand Co. (413). Books.
VARD, Inc. (416). Nuclear core control mechanisms.
Victoreen Instrument Co. (408). Radiation measuring, counting, monitoring instruments.
Vitro Corp. of America (144, 146). Nuclear activities, incl. mining, processing, etc.
Wah Chang Corp. (314, 316). Zirconium, tungsten, hafnium, tantalum, etc.
Westinghouse Electric Corp. (132, 231, 235, 237). Reactor models, equipment.
Wolverine Tube Div., Calumet & Hecla, Inc. (206). Copper, aluminum, special finned tubing.



A Reactor That Won't React — To Corrosion!

Designed for 300 psig at 450F, this reactor will be subjected to unusually corrosive service. Hastelloy, a non-ferrous nickel-base alloy, was specified to line the vessel. The ASME Code shell was first lined with narrow strips and segments by manual metallic-arc welding. Then the welds were covered by cap strips, heliarc-welded to the liner. Multiple tests confirmed the excellence of the welds. Manually welding so many feet of alloy called for the most skilled craftsmanship—the type of craftsmanship Graver has characteristically applied to alloy fabrication for years. When custom-crafted vessels in special alloys are the answer to your corrosion problem, calling in Graver assures quality fabrication, long life and dependable service.

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news from local sections

(*Continued from page* 192)

a plea for the "systems" type of approach, wherein an individual is strongly educated in the basic sciences so that he can easily relate the interactions of various phases of major projects. "Such a person," Mosley claimed, "would be of special value in a project such as missile work, where various disciplines are required."

Explaining the incorporation of the essential ingredients into engineering courses from the start, based on professional recommendations, was the objective of an invitation extended by L. C. Nelson, Director of Engineering of W. Va. Tech to the **Charleston Section** (*L. L. Cavender*). At a special September meeting at the school in response to the invitation, Nelson pointed out that it was the desire at W. Va. Tech to become better acquainted with local industry, and vice versa. Being a newcomer in the field of engineering education, the institution was able to pattern its engineering program along the lines of the current recommendations of the Engineers Council for Professional Development. Although Tech's two-year technical courses in chemical, electrical, and mechanical engineering have been accredited by ECPD, approval of the four-year program is still pending, but seems certain.

Help Yourself!

"Some people feel that management ought to take you [chemical engineers] all by the hand and lead you down the path to success and prosperity. You should do it on your own! You have to help yourself!" was the comment made by Paul Mayfield of Hercules Powder Co. during the Q&A session of **Philadelphia-Wilmington's** (*D. G. Evans*) November panel discussion meeting. "What management expects of chemical engineers" was the critical subject panelled by E. J. Goett, Atlas; R. L. Hershey, DuPont; and Mayfield. A.I.Ch.E. President G. E. Holbrook of DuPont served as panel moderator.

The Section invited this panel to present a better picture of how top management views the engineer's position in the present and future activities of the chemical industry, and what specific qualities management looks for and expects in the chemical engineer. In describing what manage-

(*Continued on next page*)

WHEN YOUR PROBLEM IS
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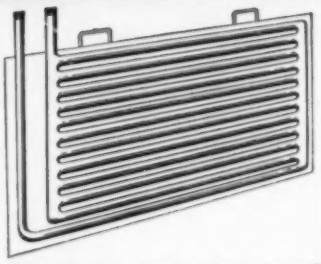
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(*Continued from page* 194)

ment expects of the chemical engineer in the field of production, Goett stated that the engineer must be basically a professional man. He must abide by the standards set forth by his profession. This includes familiarity with his company's standards. The production engineer should possess a high degree of professional skill, make every effort to acquire new skills, and keep abreast of the latest developments in science and engineering. The company has placed into the production engineer's trusteeship all of its plants, equipment, processes, and the human resources to handle these plants. It therefore has a right to expect a faithful performance in that trust.

"Management expects a maximum return on its assets," continued Goett. Therefore, the engineer in production must try to use each asset at his disposal to its fullest extent. This means being alert to possible day-to-day improvements, which, although individually small, steadily mount up and become a major factor in the advance of the company.

Some of these items are:

- **minimum manufacturing cost of specification products,**
- **maximum use scheduled for all facilities,**
- **labor managed for tranquil but efficient use,**
- **continual consideration of equipment for possible technological improvements.**

Goett cited effective communication with both technical and nontechnical personnel as rating high on the list of qualities which management looks for, and which probably represents one of the stiffest challenges to the production engineer.

Mayfield carried the ball to the fields of distribution and selling. He claimed that the engineer in sales is expected to retain his engineering talents and apply them to solving problems associated with distribution and selling. To sell in the chemical industry, a salesman first needs knowledge. He must have knowledge of his competitor's products as well as his own, and he must be aware of his customer's needs. With his technical background, the engineer is in a good position to fill this need. Next, a salesman must sell. Management wants a salesman to be a technical consultant to his own company and to his customers—on market research, business trends, industrial develop-

(*Continued on page* 198)

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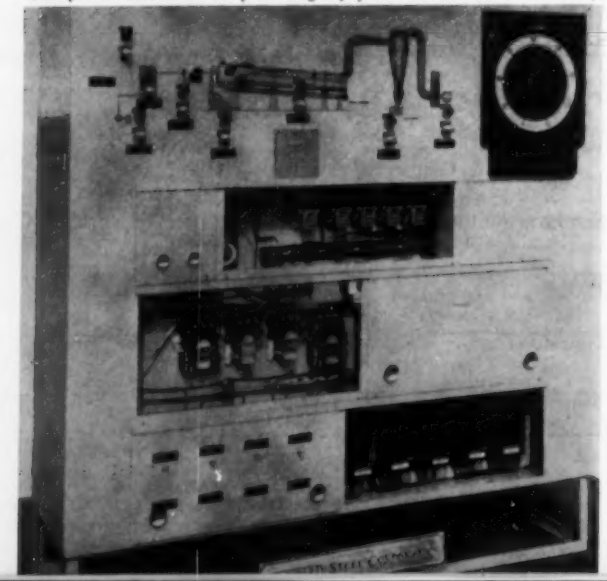
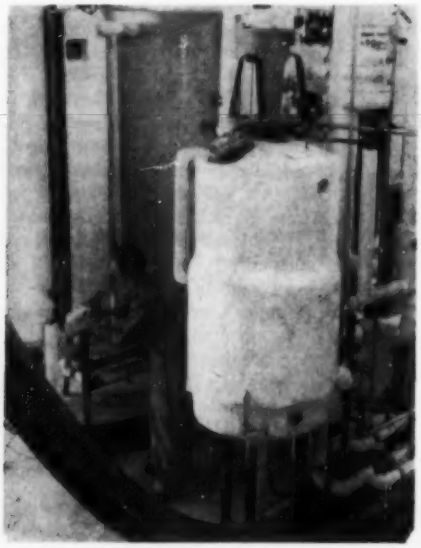
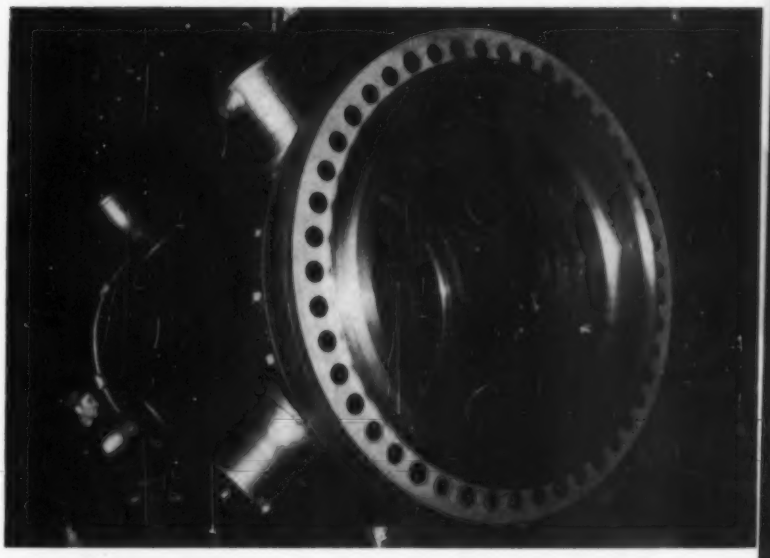
ELECTED TO FRENCH LEGION OF HONOR. Edgar L. Piret, professor of chemical engineering at the University of Minnesota, receives the medal of the Legion of Honor from Jacques Baeyens, Consul-General of France, at the Students' Luncheon during the recent Annual Meeting of A.I.Ch.E. in Chicago. In the words of Baeyens, the presentation was made to honor "not only the ability of a scientist, but also the quality of an humble man who has contributed much to our common goal—the safeguarding, and probably the survival, of our civilization." Emphasis was laid by the Consul-General on Piret's contributions to French chemical engineering science in the form of modern courses introduced into French universities, and on his unremitting efforts to bring French engineering students to the U. S. on an exchange basis.

CHEMICAL ENGINEERING, DISTAFF SIDE: Chatting here after the Chicago Students' Luncheon are (left to right) Miss Mary McNamara, a junior in chemical engineering at Illinois Institute of Technology, Ralph E. Peck, head of the chemical engineering department at Illinois Tech, Miss Unn Simonsen, a senior in chemical engineering at Purdue and an exchange student from Oslo, Norway, and J. Henry Rushton, past president of A.I.Ch.E. Miss McNamara looks forward on graduation to carving out a business-technical career in chemical engineering. Miss Simonsen hopes to work in the field of petroleum refining for a U. S. firm doing business in Norway. Above, guests at the A.I.Ch.E. Students' Luncheon in Chicago eat up heartily before address by W. K. Davis, AEC, on "Power Reactor Development."

AUTOMATED ROTARY DRYER. This graphic control board for automatic operation of a new Standard-Hersey rotary dryer was designed and manufactured by Standard Steel Corp. of Los Angeles for drying silica sand at the Owens-Illinois plant in Cuba. All dryer operations are controlled from the panel, including acceptance or rejection of feed. Board requires part-time services of only one man to supervise the operation, is an excellent example of automation of processing equipment in the chemical industry.







THIS 100-TON PRESSURE VESSEL for the prototype nuclear propulsion plant of the nation's first atomic-powered surface ship is shown prior to shipment to the Naval Reactors Facility at Arco, Idaho, by the Foster Wheeler Corp. Built for use by the Bettis atomic power division of Westinghouse (prime contractor with the AEC to design and develop the nuclear propulsion plant for the ship), the vessel has an outside flange diameter of 137 inches, shell diameter of 105 inches, and measures more than 19 feet long.

NEW HOME FOR ATLAS. Convair (Astronautics) Division of General Dynamics will begin moving personnel and equipment into this new $40 million Atlas intercontinental ballistic missile plant outside San Diego in March. Six-story office buildings in left foreground will house administrative and engineering personnel, one-story connected buildings in waffle pattern will accommodate laboratories, library, reproduction, photographic, and other supporting services. Massive factory area in background will be ready to receive equipment and personnel in April and May.

NEW UNITED ENGINEERING CENTER, looking like a smaller-sized UN, is shown in its highly strategic position in this artist's rendering. Demolition of old buildings on the site has started, with groundbreaking expected this summer. Fund-raising activities for the $10 million structure, under Kelly Committee guidance, are now in full swing.

A POLYOLEFIN PILOT RESEARCH LABORATORY is being used by Celanese to study the possibilities of creating new tailored-to-order plastics and fibers made of predesigned molecules. Monomers—the basic chemical building blocks of synthetic resins—can be made to link together in an orderly, controlled, and predictable pattern: the complex of piping, vessels, mixers, and instruments at left is part of the equipment used in the production of such ordered polymers.

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news from local sections

(*Continued from page* 195)

ment, sales forecasting, etc. He is expected to be alert, sincere, honest, imaginative, intelligent, logical, and emotionally stable. He should be able to develop new skills, exhibit job growth, and have managerial ability. In conclusion, Mayfield said: "Selling needs engineers, and engineers need selling."

R. L. Hershey delved into the present and future challenges of the chemical industry, and what management expects of chemical engineers in meeting them. He first pointed out that companies operate in a competitive economy, and that they depend on management's care for their continued existence. Continuing, he said that the best description of the chemical industry since World War II is "increased competition"; that because of the rapid growth pattern and high profitability of the industry, it has seemed to be a "promised land" to previously non-chemical companies who are now entering it for the first time; that there has also been increased competition within the industry: in research, customer service, and production efficiency. In view of this vigorous competition, the key to future growth appears to be innovation, with new products and services produced more efficiently. This means that management expects the engineer to show increased competence at all levels. In research he must recognize the unexpected; in design, minimize investment; in development, eliminate wasteful experimental time; and in marketing, obtain more realistic appraisals of market relationships.

Because of the increased complexity of marketing studies, innovation has become increasingly costly in time and money, tending to make the job even more difficult. "However," concluded Hershey, "by brainpower, supplied with knowledge, fired with imagination, and driven by the desire to excel, as an individual and as a team member, management hopes the chemical engineer can help meet these challenges. Management also looks to chemical engineers to supply some of the future managers of industry."

Speed-up with Computetrs

The answer to one aspect of these problems was given to the **Baton Rouge Section** (*M. M. Koenecke*) by Ed Newchurch of Esso's Research and

(*Continued on next page*)

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(*Continued from page* 198)

Engineering Dept. at their January meeting. He stated that one method of speeding up developmental work is to use high-speed computers. He talked about computers and how they fit into Esso's R&D work. In stressing the advantages computers offer, he said that the first companies that increase the tempo of their R&D should have a sharp advantage over competition. Specifically, Mr. Newchurch pointed out three real advantages of computers:

1. *Computers expedite research and development work.* They can be considered substitutes for data clerks, not substitutes for engineers, since they require supervision—that is, coding. The computer frees the engineer from the routine calculations he has been saddled with, allowing him time for higher level thinking and planning. By comparison, today's newest computers do 15,000 times as much calculation in a given period of time as the engineer with slide rule and calculator.

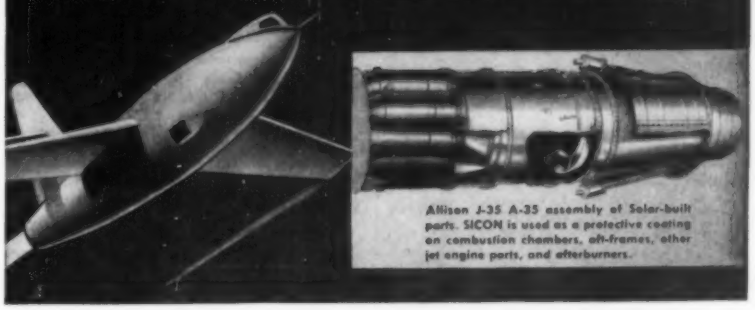
2. *Computers do a better job of design.* Use of computers has saved Esso millions of dollars in the design of new refineries, by permitting closer tolerances and integration of equipment. In the field of operations research, where decisions are based on many complex aspects of business, computers permit management to make more reliable decisions.

3. *Computers increase the scope of the research and development effort* and allow study of problems that had to remain unstudied because of lack of available time and lack of evaluated data. Use of computers makes it possible to eliminate the bottleneck and permit study in fringe areas without sacrificing the important problems.

Newchurch emphasized that these advantages are not the starry-eyed report of some optimistic engineer. Esso has established them by comparison with older hand methods. To emphasize his statements, he cited that Esso has increased its computer facilities rentals 70 times in the past 7 years, with a substantial unit cost reduction. In actual numbers, pricing a man-unit of work at $300 using manual computation methods, the larger computers can do 15,000 units of work in the same time at $1.00 per man-unit.

(*Continued on page* 201)

PROTECTING JET ENGINE PARTS *with* Sicon Silicone Coating



Allison J-35 A-35 assembly of Solar-built parts. SICON is used as a protective coating on combustion chambers, aft-frames, other jet engine parts, and afterburners.

Operator masks end of combustion chamber with simple cardboard shields as he applies SICON finish to resist temperatures up to 800°F.

This J-35 afterburner shroud assembly has been masked at critical hole patterns and threaded attachments before being sprayed with SICON silicone coating.

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An example of how SICON solves Finish Problems for Design Engineers.

Jet engine parts made by Solar Aircraft are fabricated from special aluminized steel to meet conditions of extremely high temperatures. Certain welding operations destroy the aluminized surface, and at such critical points SICON was first adopted as a touch-up finish to renew vital protection needed. SICON proved stable under searing heat tests due to its strong film adhesion and excellent heat resistance characteristics, also so easy and fast to apply that many parts are now given an all-over SICON coating.

Rigorous heat tests have proved SICON best for many other products such as automobile manifolds, exhaust pipes, furnaces, and heaters. SICON is easy to apply, by brush, spray, or dip, to any chemically clean surface; and in many cases can be either air-dried or baked.

Decorative colors for lower temperature needs—whites, beiges, tans, and other shades, all with excellent retention of color and gloss in the 550°F. range, are now available.

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The product of our specialized hand... small diameter stainless steel and special alloy tubing drawn to the ultimate in precision perfection ...is basic in the plans and accomplishments of America's foremost "Atomic" manufacturers!
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The Mark of Quality
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• *TMI's Atomic Experience is at your service from the initial plans to the final proven specifications. Specializing in stainless steel and special alloy tubing—in small diameters, .050" to .625" O.D. with tolerances as close as .001" when required.*

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CANDIDATES FOR A.I.Ch.E. MEMBERSHIP

The following is a list of candidates for the designated grades of membership in A.I.Ch.E. recommended for election by the Committee on Admissions. These names are listed in accordance with Article III, Section 8 of the Constitution of A.I.Ch.E.

Objections to the election of any of these candidates from Members and Associate Members will receive careful consideration if received before March 15, 1958, at the office of the Secretary, A.I.Ch.E., 25 West 45th Street, New York 36, N. Y.

MEMBER

• Atkinson, Charles D., *Wilmington, Del.*
• Bressler, George H., *Springfield, Pa.*
• Chapin, William F., *Houston, Tex.* Cherubin, Louis J., *Schenectady, N. Y.* Clements, George L., *Mars, Pa.*
• Duren, Guy W., Jr., *Bartlesville, Okla.*
• Ellingson, K., *Kirkwood, Mo.*
• Farrow, William H., Jr., *Wilmington, Del.* Franz, Carl J., *Mendham, N. J.* Fuentes, Manuel N., *Texas City, Tex.*
• Gomsi, Arne E., *Vestal, N. Y.*
• Horton, Francis, *Tuckahoe, N. Y.* Howe, Edwin C., *Minneapolis, Minn.* Huckaba, Charles E., *Gainesville, Fla.*
• Knoepfel, Rudolf W., *Sao Paulo, Brazil.*
• Longacre, Alan, *Whittier, Calif.*
• Massey, C. T., *Texas City, Tex.* Mayer, Peter C., *Berkeley, Calif.* Myers, John C., *Lake Jackson, Tex.*
• Nagle, R. E., *New York, N. Y.* Nicholls, Richard W., *Perth Amboy, N. J.*
• Row, Harold S., *Pasadena, Tex.*
• Schmidt, Werner H., *Tenafly, N. J.* Seebold, James E., *Flossmoor, Ill.*
• Weatherford, W. D., Jr., *Pittsburgh, Pa.* Whitaker, Robert K. E., *Matraville, N. S. W.* Wood, Neal V., Jr., *Pittsburgh, Pa.*

ASSOCIATE MEMBER

• Ban, Thomas E., *Cleveland, Ohio.* Basket, David E., *Holland, Mich.* Beatty, Robert N., *Idaho Falls, Idaho.* Bressler, Marvin, *Baltimore, Md.*
• Cain, D. J., *Unionville, Pa.* Cale, John Warren, *Kingston, Ontario, Canada.* Cantillo, Robert A., *E. Boston, Mass.* Carl, Ralph W., *Hammond, Ind.* Caron, Philip E., *Longview, Wash.* Celenza, Gaetano Joseph, *Philadelphia, Pa.* Collins, Arthur, *Rosharon, Tex.* Coshburn, Henry S., Jr., *New York, N. Y.*
• Daigle, Earl Allen, *Freeport, Tex.* Dowden, Clarence L., Jr., *Port Arthur, Tex.* Dranoff, Joshua S., *New Haven, Conn.* Duff, William W., *Collingswood, N. J.* D'Wolf, James F., *Wilmington, Del.*
• Fetzer, William W., *Charleston, W. Va.* Fried, Herbert M., *Yonkers, N. Y.*
• Goldstein, Arthur L., *Newark, Dela.*
• Herrick, Robert A., *Cincinnati, Ohio.*
• Ingallinera, Manuel, *Huntington, W. Va.* Ivie, Jerry W., *Pasadena, Tex.*
• Kostansek, Paul A., *Parma Ohio.*
• Lasure, Richard M., *Portsmouth, Ohio.* Leek, Chapman B., *Idaho Falls, Idaho.*
• Maloney, William J., Jr., *Wilmington, Del.* Manon, John J., *Washington, D. C.* McCluer, Henry K., *Long Beach, Calif.* McLaughlin, William F., *Newark, Del.* Mettes, David Garth, *Midland, Mich.* Michalik, Edward S., *Oakland, Calif.* Mirocznik, Ella Yael, *New York, N. Y.* Murphy, William E., *Louisville, Ky.*
• Naber, John F., *Crum Lynne, Pa.*
• Rainwater, Jewel G., *Batesville, Ark.* Richards, James C., *Bel Air, Md.* Riskevics, Karlis F., *Kalamazoo, Mich.* Roberts, Richard

(Continued on next page)

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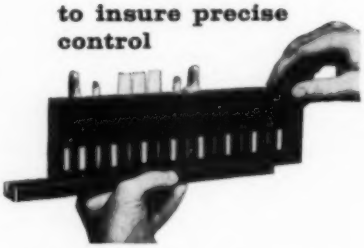

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news from local sections

(Continued from page 199)

Also Meeting

The plastic red herring (*Harengus Rubrus*) was given by the **Boston Section** Icthyologists to Earl P. Stevenson, chairman of Arthur D. Little, Inc., at their November meeting. The recipient of H.R. is the chemical engineer the members of the Boston Section elect to the honor; he is now a holder of the honorary title "Kingfish of the Icthyologists." Stevenson addressed the meeting on the problem of communication between those with and without technical training. Also present were 50 student engineers from local colleges, and a panel composed of Stevenson, Walter Whitman, ex-president of A.I.Ch.E. and chairman of the Dept. of Chem. E. at M.I.T., and Wm. T. Nichols, A. D. Little. The panel answered student questions on careers in engineering.

One of the major problems in the manufacture of urethane foams is the long reaction time, according to J. M. McClellan, Wyandotte Chemicals, speaking to the October meeting of the **Detroit Section** (*C. B. Armstrong, Jr.*). But urethane foams have such good properties that they are finding wide use despite certain production problems. Most significant is the range of properties attainable: they can be soft and resilient, rigid and tough. Among their other properties they are: of low density, flame resistant, adhere to most surfaces, foam in place, have low thermal conductivity, and deaden sound.

CANDIDATES

(Continued)

K., Clinton, Iowa. Rodriguez, Manuel, Baton Rouge, La. Rohaus, Donald E., Monroeville, Pa. Rosenthal, Stephen E., New York, N. Y. Rosson, Harold F., Lawrence, Kansas. Russell, William N., Stamford, Conn.

• Saccacio, Dominick, J., Alexandria, Va. Shaffert, Kurt, Stamford, Conn. Shupe, William R., Linden, N. J. Smith, Donald F., Marcus Hook, Pa. Smith, Joseph A., Jr., Baton Rouge, La. Smouse, Robert J., Dallas Tex.

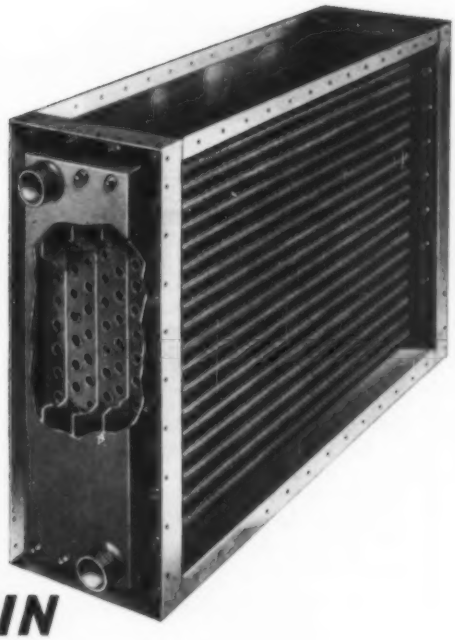
• Tarver, Donald A., Lynchburg, Va. Turman, John D., San Mateo, Calif.

• Van Gelder, W., Allentown, Pa. Vaughn, Raymond L., Akron, Ohio.

• Watters, James H., Torrance, Calif. Workman, William S., Elizabeth, Pa. Wynnemer, Donald J., Baytown, Texas.

AFFILIATE

• Garratt, M. W., Jr., Mill Brae, Calif.
• Parker, Robin J., Riverside, Ill.



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Completely drainable and easily cleaned, Aerofin Type "R" coils are specially designed for installations where frequent mechanical cleaning of the inside of the tubes is required.

The use of ⅝" O.D. tubes permits the coil to drain completely through the water and drain connections and, in installations where sediment is a problem, the coil can be pitched in either direction. The simple removal of a single gasketed plate at each end of the coil exposes every tube, and makes thorough cleaning possible from either end.

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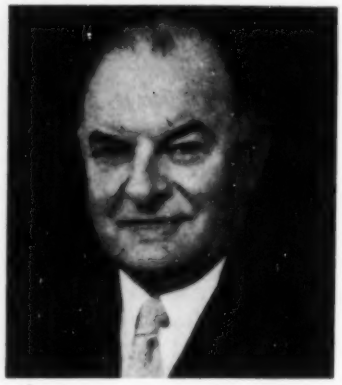
MEDAL WINNER



The Chemical Industry Medal for 1958 will go to **Fred J. Emmerich,** past chairman of the Board of Directors of Allied Chemical & Dye. The award "for conspicuous services to applied chemistry" was made by the American Section of the Society of Chemical Industry, donor of the medal. Actual presentation of the medal will be made at the Society's annual meeting in Toronto, Canada, in September. Emmerich will be the twenty-fifth recipient of the medal.

New development engineers at Speer Carbon Co., St. Marys, Pa., are **Arthur L. Olender** and **Samuel L. Hoff.** Olender comes to Speer from Union Carbide, and Hoff from the Columbia Mineral Beneficiation Laboratory in New York.

W. J. Goodrum appointed senior chemical engineer in the Buffalo, N. Y. research division of Spencer Kellogg and Sons. Goodrum has been in the production division of Spencer Kellogg for nine years, the last two spent at the company's mill in Minneapolis, Minn.

Among technical men previously employed at the recently-closed Brownsville, Texas, plant of American Oil Co. and now transferred to Amoco's Research and Development Department in Texas City are chemical engineers **John J. Hagan** and **Donald J. Shrecengost.**

Willis M. Cooper, assistant general manager of Monsanto's Research and Engineering Division in St. Louis, will attend the spring session of the Advanced Management Program at Harvard's Graduate School of Business Administration.

The Priestley Medal of the A.C.S. for 1958 has been won by **Ernest H. Volwiler,** president and general manager of Abbott Laboratories, Chicago, Ill. Volwiler's contributions to medicinal chemistry have included development of manufacturing techniques for such anesthetics as Anesthesin, Benzocaine, Novocaine, and Pentothal.

George G. Lamb, professor of chemical engineering at Northwestern University Technological Institute, is one of five American educators selected to supervise establishment of an engineering school at Godjah Mada University in Java.

Donald F. Othmer, head of the Department of Chemical Engineering at the Polytechnic Institute of Brooklyn and a director of A.I.Ch.E., will present a paper at the European Federation for Chemical Engineering Congress in Frankfurt am Main, West Germany, on June 2 during the 1958 ACHEMA meeting. Othmer, whose paper on "Acetic Acid Recovery Methods" represents 30 years of work in this field, is the only American invited to give one of the plenary lectures at this year's ACHEMA Congress.

Alfred T. Loeffler, vice-president of Food Machinery and Chemical Corporation, is assuming functional responsibility for the marketing activities of that firm's chemical divisions.

William L. Rodich has been elected vice-president in charge of operations for Celotex Corp. Located in Chicago, Rodich will be responsible for the manufacturing, engineering, purchasing, and traffic activities of the company.

Dewey and Almy Chemical Co. announces the appointment of **Thomas G. Gibian** as general manager of their Organic Chemicals Division. Gibian succeeds **Russell L. Haden,** who has joined the Virginia-Carolina Chemical Corp.

Alfred R. Powell, special adviser to the research department of Koppers Company, Inc., has won the 1957 Pittsburgh award of the American Chemical Society's Pittsburgh Section. Powell is an authority in fuel technology.

The American Society of Mechanical Engineers announces the retirement of **C. E. Davies** as secretary after 23 years of service in that office. Davies will continue to serve as coordinator for the United Engineering Center.

Miller V. Sparks, associated with the Mission Manufacturing Company for 23 years, has been appointed director of public relations for that firm. Mission is a manufacturer of centrifugal pumps for the chemical process industries.

A. M. Cox, president of J. P. Devine Manufacturing Co., Pittsburgh, has been elected president of the Small Business Association of the Pittsburgh area.

New officers for 1958 of Engineers Joint Council are **Enoch R. Needles,** consultant, as president, and **O. B. J. Fraser,** assistant manager of International Nickel's Development and Research Division, as vice-president.

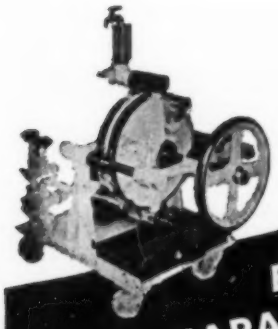
Needles

D. J. Wynnemer has joined the Research and Development Division at Humble Oil and Refining's Baytown, Texas, refinery and **C. N. Coleman** has returned to the Baytown Technical Service Division from military service.

DuPont elects **Robert L. Hershey,** general manager of its Polychemicals Department, as director, vice-president, and member of the Executive Committee.

Vannevar Bush named chairman of the Board of Directors of Merck & Co. Bush has been a member of the Board's executive committee since 1949 and has devoted particular attention to the company's scientific work.

(*Continued on page* 204)



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Equipped with 3 gpm pump and electric motor. Stainless steel or bronze nickel plated circulatory system. Holds 4 to 8, 12-1/4" dia. disks.

Ertel Portable SMALL CAPACITY FILTERS

EFS-B filter is recommended for small batches where sludge or filter aid is required. Also advantageous because no rubber washers are required . . . the asbestos sheets form their own seal. The EBW filter is ideal for high polishing filtration using filter pads.

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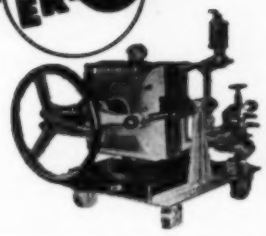

EFS-B Model Filter
Designed for use with any type filtering medium, 12" x 12" square. Single hand wheel provides trouble-free operation. Bronze nickel plated or stainless steel circulatory system.

- **Save Initial Costs**
- **Eliminate Costly Maintenance**

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in
MEASURING FLOW
thru
PARSHALL FLUMES

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BURGESS-MANNING TYPE "ML" METER INSTALLATION

You completely eliminate such installation costs as: excavation for dry well; concrete dry well foundation and walls; metal float well and cover; connecting telltale piping, valves and fittings between Parshall Flume and float well; float cable and protecting piping; clear water piping and fittings for back-purge system, and metal grating to cover dry well.

And, most important, the only maintenance you will have is the possible hosing off, in a few seconds, of the float once in many weeks. Receiver may be located up to 5000 feet from transmitter.

Write for Burgess-Manning "ML" Meter Bulletin.

Think of the savings! Think of the elimination of maintenance!

BURGESS-MANNING COMPANY
Penn Instruments Division
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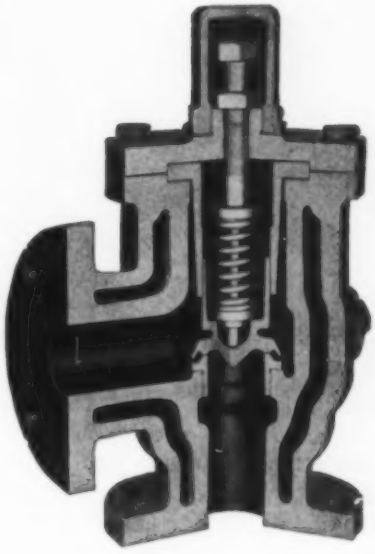
Jacketed RELIEF VALVES



Designed especially for heavy viscous products such as asphalt, waxes, plastics, heavy oils and pitches, this valve is fully jacketed for maximum heating efficiency. The disc is of top guided design, removing all flow interferences inherent in bottom guided types. Gasketed cap covering adjusting screw provides zero leakage.

Valve seats may be removed or repaired without removing valve from line.

Standard valves in stock are semi-steel with iron trim in 2" x 3" and 3" x 4" sizes rated @ 450°F or 150% steam maximum jacket pressure. Set pressures range from 5–125%.

Steel and stainless steel bodies and trim, Teflon faced disc available on order.

Write for dimension sheet and prices.

Parks-Cramer Company
PROCESS HEATING DEPARTMENT
FITCHBURG 6, MASSACHUSETTS

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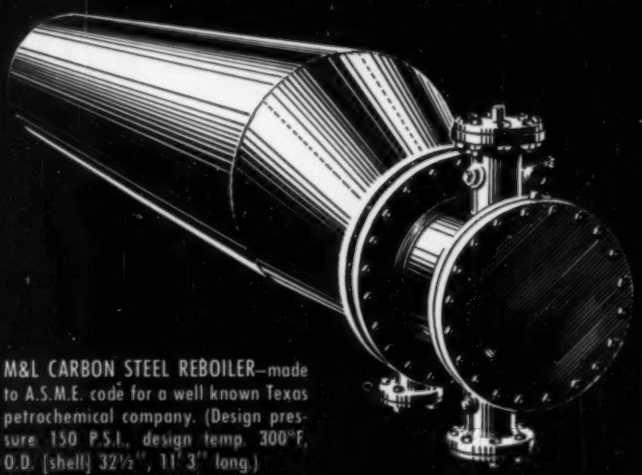

M&L CARBON STEEL REBOILER—made to A.S.M.E. code for a well known Texas petrochemical company. (Design pressure 150 P.S.I., design temp. 300°F, O.D. [shell] 32½", 11' 3" long.)

Today's rapid strides in the technology of processing plant operation make it essential for a manufacturer of equipment to be "staffed up" with people who have had extensive training and experience. More than half our staff have spent a major part of their working life in this one field and have played a major role in the design and fabrication of many types of processing equipment. They know the limitations and workability of all metals and how to get maximum service from each. This accumulated knowledge of base materials and our extensive experience in design and fabrication means practical, trouble-free equipment at the lowest possible cost.

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Dept. B

DESIGNERS & MANUFACTURERS OF QUALITY HEAT EXCHANGE EQUIPMENT

people
(management & technology)

(*Continued from page 202*)

New general manager and secretary of the Chemical Institute of Canada is **T. H. Glynn Michael,** formerly director of research, Howards & Sons (Canada) Ltd., Cornwall, Ontario. In addition to his duties as executive officer of the Institute, Michael will also serve as managing editor of the C.I.C. publications *Chemistry in Canada* and *The Canadian Journal of Chemical Engineering.*

Michael

Hercules Powder names **Harold R. Monfort** as assistant manager of its Missouri Chemical Works, Louisiana, Missouri. Monfort was formerly manager of Hercules' pentaerythritol and plasticizer plant at Mansfield, Mass., where he will be succeeded by **Einar West,** previously assistant plant manager at Mansfield.

B. W. Jesser will be the new manager of Kellogg International, subsidiary of M. W. Kellogg of New York. With Kellogg since 1942, Jesser was formerly manager of the company's design engineering department.

Jesser

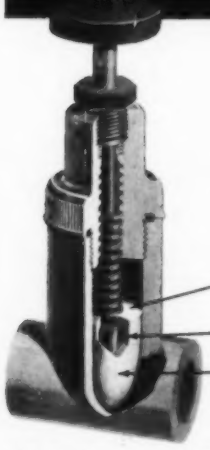
Thomas H. Goodgame, formerly in charge of research and development for Texas Butadiene & Chemical in Houston, appointed associate professor of chemical engineering, Georgia Institute of Technology.

New staff members at Linde Co.'s Tonawanda, N. Y. laboratories are **Aubrey M. Kirby, Jr.** and **S. L. Wang.** Kirby is working in the process metallurgy section of the Research Laboratory, while Wang is involved in the application of high-speed computers.

Solvay Process Division, Allied Chemical & Dye, appoints two new vice-presidents—**Wilbur H. Brumfield,** who will assume increased administrative and executive duties in the firm's New York office, and **Cortez P. Hackett,** who, located in Syracuse, N. Y., will be in charge of all Solvay's operating and development department functions.

(*Continued on page 206*)

NEW! ALL-PLASTIC GATE VALVE



VANTON
FLEX-PLUG* VALVE
½"- 2" sizes

- No-pressure-drop construction of gate valve
- Throttling flow-control feature of globe valve
- PVC or styrene-copolymer construction
- Handles wide range of corrosives and slurries

- Back-seating feature of cap: when valve completely open, relieves pressure on packing.
- Free-to-swivel plug: provides even wear of cap, perfect closure.
- Flexible synthetic cap: easily replaced without removal of valve from line; minimal maintenance. Handles abrasive slurries without wear.

- All-plastic design — PVC or styrene-copolymer. Replaceable caps available in Neoprene, Buna-N, and Hypalon (Kel-F elastomer on special order).
- Suitable for vacuum — resilient cap makes excellent seal.
- Adaptable to all existing plastic pipe and fittings; especially suited to Vanton P, S, and N lines of plastic pipe and fittings.
- Rated for 150-lb. service — PVC line up to 140°F., styrene-copolymer line to 170°F.

*Pat. Pending

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Flanders Airpure Filters insure against product rejection due to sub-micron dust particles.

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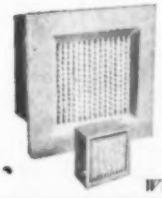
- Large capacity and low corresponding pressure drop means top performance.



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multiple whirlpools screen materials previously un-screenable

The Vorti-Siv successfully screens powders, liquids and slurries in meshes from 4 to 400. Mesh sizes are changed quickly and easily. It has made practicable the screening of materials that heretofore were regarded as un-screenable on a commercial basis.

The whirlpool action, variable in both speed and size, is what sets the Vorti-Siv apart from conventional screening machines . . . allows greater throughputs with fine mesh screens.

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The Hoshall Company
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Atlanta, Georgia

Mich.
Harry Holland & Son, Inc.
10600 Puritan Avenue
Detroit 38, Michigan

Calif.
The Moore Drydock Co.
Ft. of Adeline Street
Oakland, California

Mexico
Sada y Himes S.A.
Apartado 911
Padre Mier 1250 Pte.
Monterrey, N.L. Mexico

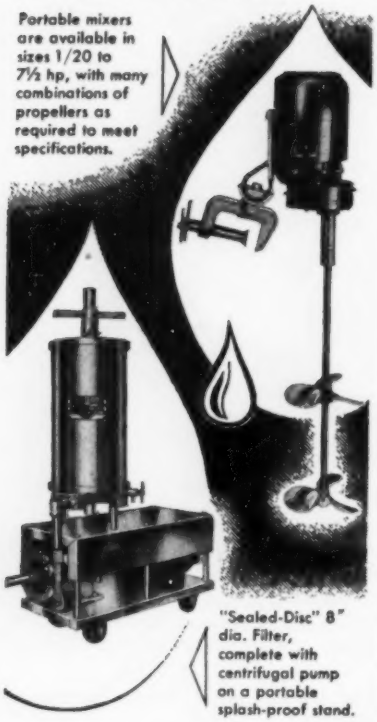
COST CUT with *Portable*

LIQUID PROCESSING EQUIPMENT

Alsop light weight portable liquid processing equipment proves its cost savings daily in thousands of applications.

Easily moved from job to job, this versatile equipment eliminates the need for numerous, costly fixed installations. Now is the time to prove this in your plant!

Portable mixers are available in sizes 1/20 to 7½ hp, with many combinations of propellers as required to meet specifications.



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ALSOP ENGINEERING CORPORATION

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Milldale, Connecticut

(*Continued from page* 204)

B. D. Thomas is the new president of Battelle Memorial Institute, Columbus, Ohio, succeeding Clyde Williams, who has retired. Thomas, with Battelle since 1934, was a key figure in the establishment of its research laboratories in Frankfurt, Germany, and Geneva, Switzerland.

Thomas

Carwin Co., North Haven, Conn., announces election of **Donald A. Bender** as vice-president. Formerly corporate secretary, Bender's duties will be broadened to include responsibility for the operations of the company's Chemical Division.

Allied Chemical & Dye announces appointment of **Irb H. Fooshee** as president of its General Chemical Division. Fooshee was named executive vice-president of the division in July, 1957, following three years as vice-president in charge of development. Prior to joining the General Chemical Division in 1947, he was vice-president of Neches Butane Products Co., Port Neches, Texas.

New secretary of the A.S.M.E. is **O. B. Schier, II,** succeeding **Clarence E. Davies,** who served in that office for 23 years.

Production manager of the new $38 million high-energy fuels plant under construction by Callery Chemical for the Navy at Muskogee, Oklahoma, will be **Gradon F. Willard.** Before joining Callery as a chief project engineer, Willard had been associated with Great Lakes Chemical and Celanese Corp.

Willard

Chief process engineer at the Muskogee plant will be **Stanley E. Dale.** Dale has been associated with Callery in Pittsburgh for the past seven years.

Former managing editor of the now defunct McGraw-Hill publication *Petroleum Processing,* **William C. Uhl,** has joined the staff of Esso Research and Engineering Company as technical editor in the firm's technical information division.

James D. Moore, chief process engineer, has been promoted to production manager of Vitro Uranium Co. Moore, who joined Vitro in 1951 as a chemical engineer, will be responsible for all plant operation, engineering, maintenance, and process research and development.

New staff member at Badger Manufacturing Co., Cambridge, Mass., is **William K. Henze,** process engineer.

Fred W. Elliot has been elected vice-president of H. K. Porter Co. Elliot came to Porter in 1956 from the Pennsylvania Industrial Corp. His prior experience includes association with Battelle Memorial Institute, Columbus, Ohio.

Clifford F. Rassweiler, Johns-Manville vice-president for research and development, takes office as new president of A.C.S. He succeeds **Roger J. Williams** of the University of Texas.

Corn Products Refining Co. has named **Robert C. Wheeler** to the newly-created post of vice-president for personnel and public relations and **Alfred S. Wells** to the position of vice-president for purchasing.

Wheeler

In the Technical Service Division at Humble Oil & Refining Company's Baytown, Texas, refinery, **W. G. Denning** has been promoted to section head; **J. W. Alliston, J. M. Andrews,** and **K. K. McMillin** to technical specialists; and **C. L. Umholtz** to senior chemical engineer; also at Baytown, **T. J. Greaney** and **G. W. Wilson** have been appointed as assistant division heads in the Technical Service Division; **R. B. Bennett** and **E. J. Hoffmann** have been promoted to research specialists in the Research and Development Division.

A.I.Ch.E. Past-President **J. H. Rushton** has been elected an honorary member of the Institute of Chemical Metallurgical & Mining Society of South Africa.

Armour Research Foundation, Illinois Institute of Technology, advances **William M. Langdon** to senior engineer in the chemistry and chemical engineering department. Prior to joining the Foundation in 1956, Langdon managed his own consulting firm, Langdon & Associates, Algonquin, Ill.

(*Continued on page* 208)

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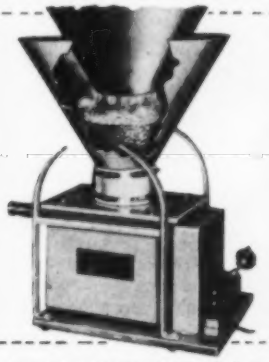

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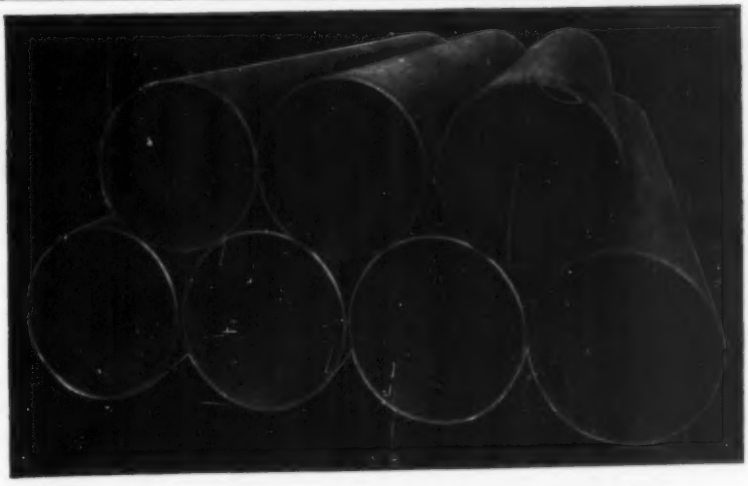

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(*Continued from page 206*)

Reitmeier

R. E. Reitmeier, specialist in industrial catalyst technology, has been named president of Catalysts and Chemicals, Inc., Louisville, Ky., of which he was one of the founders.

Among recent promotions and reassignments at Monsanto are: **Fred J. Holzapfel** to associate director of engineering, and **M. Peter Lux** to project section manager, both in the firm's Organic Chemicals Division, St. Louis; **Malcolm C. Lowe, Jr.,** to project manager in the St. Louis Inorganic Chemicals Division, and **Robert E. Bilger** to technical superintendent at the Queeny plant, St. Louis. Also at Monsanto, **H. G. Schleicher** becomes resident research manager at the company's Dayton, Ohio, research laboratories, **R. I. Dunlap** is named director of research administration at Springfield, Mass., and **W. H. Lane** is appointed assistant director of research at Texas City.

Byron D. Babcock, chemical engineer at DuPont's Washington Works, Parkersburg, W. Va., promoted to research supervisor in the research division, Polychemicals Department, Experimental Station, Wilmington, Del. In his new position, Babcock will direct research on process development for the manufacture of Teflon 100X perfluorocarbon resin.

American chemical engineering know-how will be made available to Mitsui Petrochemical Industries, Ltd., Japan, by Scientific Design Company, Inc., N. Y. C., through project manager **E. J. Fradkin,** who left for Tokyo in December.

A former principal with Joseph M. Cook & Staff of Philadelphia since 1947, **James J. Armstrong,** has just been appointed director of management engineering for Allied Chemical & Dye.

Haden

A former executive of Dewey and Almy Chemical Co. in Cambridge, Mass., **Russell L. Haden, Jr.,** has been named general manager of the Chemicals Division of Virginia-Carolina Chemical Corporation.

Union Carbide announces the appointment of **Arthur P. Moss** as works manager of Union Carbide Chemicals Co.; new technical personnel at Carbide's Institute, West Virginia plant are: **W. F. Allen, R. S. Hammerness, J. A. Helm, Jr., J. F. Lombard, S. G. Panayides,** and **W. H. Rogers;** among those joining Carbide at South Charleston, West Virginia are: **J. B. Cropley, B. Gumowski, H. E. Kyle,** and **E. A. Lavergne.**

The designer of the world's first glasslined spherical chemical reactor, **Carl S. Brown,** has been promoted to product development manager for Glascote Products, Inc., Cleveland.

L. E. Johnson, supervisor of industrial chemistry at International Nickel, will be the lecturer at a Spring Term course on Commercial Chemical Development at the Columbia University School of Engineering.

Newly elected officers of Eastern Division, American Council of Independent Laboratories, Inc., include: **Foster D. Snell,** chairman; **Murray Berdick,** vice-chairman; and **Robert Stoudt,** secretary-treasurer.

(*Continued on page 212*)

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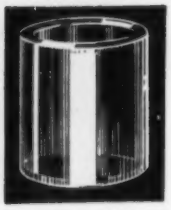

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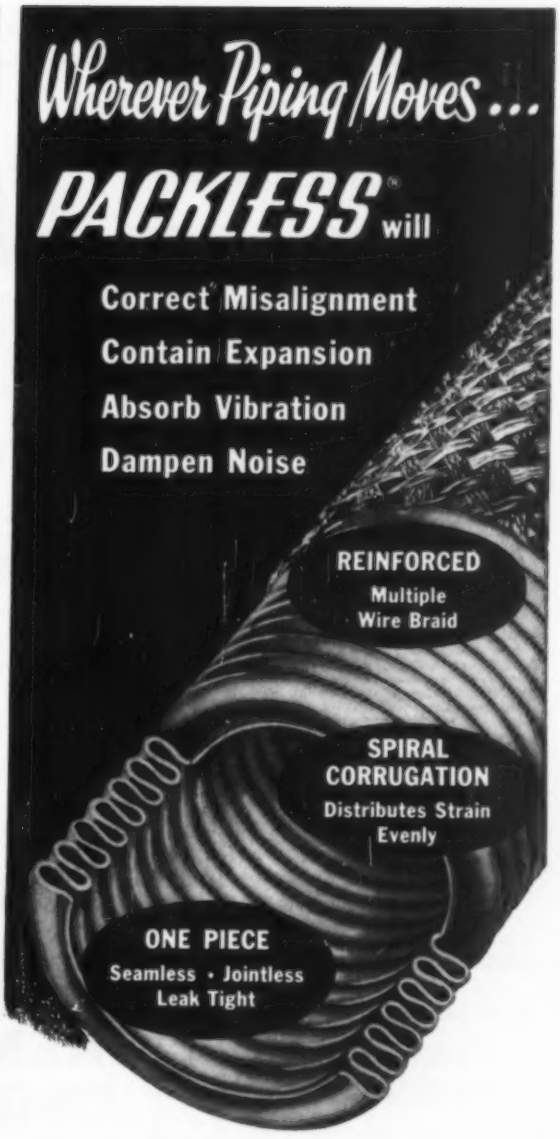

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(*Continued from page 210*)

CHEMICAL ENGINEER—Age 33. Family. Four years' experience process development—fatty acid derivatives. One and one-half years' process design—petroleum products and petrochemicals. Seeking responsible and challenging position in process development or design. Prefer Southwest or West. Box 11-2.

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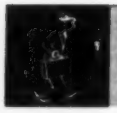

people (marketing)

(*Continued from page* 208)

Catalysts and Chemicals, Inc., of Louisville, Ky., announces appointment of **Earl Englert** as sales manager. Englert recently held the position of manager of catalyst sales for the Catalyst Department of the Girdler Co.

Englert

The Sohio Chemical Company in Lima, Ohio, announces the promotion of **Sylvester Grant, Jr.** to the post of technical service representative. Previously, Grant worked with customer services in Sohio's sales service and development laboratory.

Bert S. Taylor, president of the FMC Organic Chemicals Division of Food Machinery and Chemical Corp., has been named director of marketing and purchasing. Taylor was manager of the development department of Ohio-Apex Chemical Co., Nitro, W. Va., at the time of its acquisition in 1956 by Food Machinery and Chemical.

Taylor

Donald F. Baumler has been appointed district sales manager of the new Downingtown Iron Works. He will handle Downingtown steel and alloy plate fabrication and heat exchanger sales in the company's Buffalo territory.

The Truland Chemical Co., Inc., Division of the Trubek Laboratories of East Rutherford, N.J., announces the appointment of **John N. Adsit** to the sales department. Adsit was formerly in technical sales with Celanese Corporation of America.

Stuart G. McGriff has been appointed Callery Chemical Co. product manager, fuels and propellants. He will be in charge of the marketing of Callery's new high energy boron fuel, HiCal.

McGriff

New manager of the Boston office of the Enjay Company, Inc., petrochemicals marketing firm, will be chemical engineer **Jack Arnold, Jr.**

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A salute to the past is only part of the celebration. The main theme of the Jubilee program next June at Philadelphia will be "A Look to the Future." Here is the real significance of May CHEMICAL ENGINEERING PROGRESS for all advertisers—chemical engineers dedicated to the growth and development of all chemical industries.

This is truly a *golden opportunity* for manufacturers to instill both their corporate and their product messages in the minds of responsible chemical engineers—men whose decisions are essential to the purchase and specification of practically all chemicals, equipment, materials and engineering services in the chemical process industries.

Highlights of May C.E.P. include a History of Chemical Engineering and A.I.Ch.E., and a survey of Chemical Engineering Around the World, plus other fascinating features and timely engineering articles. This matchless editorial selection will insure intensive, effective readership.

Take full advantage of this unusual opportunity. The May 1958 issue of C.E.P. will be a big issue—your big opportunity to get big results. Be sure to reserve *adequate* space.

CEP CHEMICAL ENGINEERING PROGRESS

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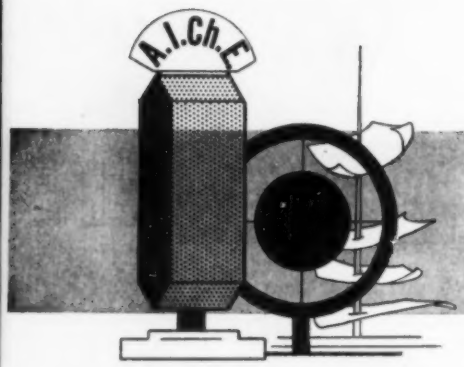

NEWS and NOTES from A.I.Ch.E.

Golden Jubilee Support . . .

The readers of *Chemical Engineering Progress* are no strangers to the drum beating that has been going on for the Fiftieth Anniversary. . . . News of this event, which we are hoping to make outstanding in the annals of our meetings, has also reached the ears of many companies & a number have inquired how they may aid in the celebration . . . As all members of A.I.Ch.E. well know, & those who have run meetings for the Institute will especially remember, it is our established practice that all expenses of meetings be borne by those who attend . . . however, because of the commemorative features of the June meeting & because so many companies wanted in some way or another to help A.I.Ch.E. in this celebration, Council decided that the extra costs might appropriately be shared by industry as well as by individuals . . . Council therefore authorized the President of the Institute to extend to representative companies in the chemical & allied fields an opportunity to participate through direct financial support . . . As of this writing the companies in the chemical field are willingly contributing & this notice is published so that firms that may not have received a letter from our President but would like to help in the event may be assured that their support will be welcome . . . Names of contributing firms will be listed in the programs & the volumes that we plan to publish on the Fiftieth Anniversary. . . . The cooperation that we are getting for the Jubilee is especially gratifying as many of these companies have also been asked to contribute toward the **United Engineering Center.** . . . Our official representatives in the United Engineering Center Campaign . . . Ray Genereaux; J. J. Healy, Jr.; Albert Frye; Carl Prutton; R. B. Semple & R. P. Dinsmore . . . are busily engaged in trying to raise part of the five million dollars the U.E.C. needs from industry. . . . Soon there will be a member campaign, as well, for the $300,000 that we have been assigned to raise from our membership as our contribution to the U.E.C. . . . There will be much more information about this . . . The other four founder societies have already swung deeply into their campaigns & we trust that this Jubilee Year will see us off to a good start . . . We hope to have most of the pledges in no later than November of this year . . . Our representatives in the Member Gift Campaign are W. G. Whitman and S. D. Kirkpatrick. . . . **Committee reports continued** . . . On pollution control Roy F. Weston, chairman, summarized his annual report . . . & Jerry McAfee, director & chairman for 1958 of the Professional Development Committee, summarized the actions of this group, which worked in 1957 under Frank E. Reese . . . Council broadly outlined the scope of the committee . . . The Publications Committee, with Ken Kettenring chairman, reported on long-term financing & plans for A.I.Ch.E. in the publication area . . . R. L. York, chairman, told of the activities of the Public Relations Committee . . . & Council empowered it to study specific ways to raise funds to produce & distribute a film for career guidance & to prepare a prospectus for presentation to Council as soon as possible . . . There was a review of the proposed publicity for the Fiftieth Anniversary Meeting . . . Then in the program area L. J. Coulthurst ended his term as chairman of the committee, giving the last of five reports to Council over the past year, in which the completely reorganized functions of the Program Committee were outlined . . . & the final committee report was from Brymer Williams, Chairman of the Student Chapters Committee, who told of progress during the year . . . There are now 108 Student Chapters in the A.I.Ch.E. . . . Committee reports occupy a large part of Council meetings because it is through committee activities that much of the progress of our organization is achieved . . . Council must therefore continually evaluate each committee's program and accomplishments & determine on what new areas to concentrate. . . . **Nuclear Engineering Division,** first division of A.I.Ch.E., reported a gain in members during the year, with a total of 651 . . . & it looks like a busy year for this organization, too, with symposia planned for the Nuclear Congress, March 17-21 in Chicago, & a symposium on Chemical Engineering Aspects of Heavy Water Reactors at Montreal, April 20-23 . . . The division is sponsoring a nuclear engineering program at the Fiftieth Anniversary Meeting, June 22-27 in Philadelphia . . . & in December, 1958, at Cincinnati is holding a symposium on Reprocessing of Fluid Reactor Fuels . . . A number of other symposia are in the planning stage . . . the division this year has been directed by Herbert S. Isbin, chairman, and Charles E. Dryden, secretary.

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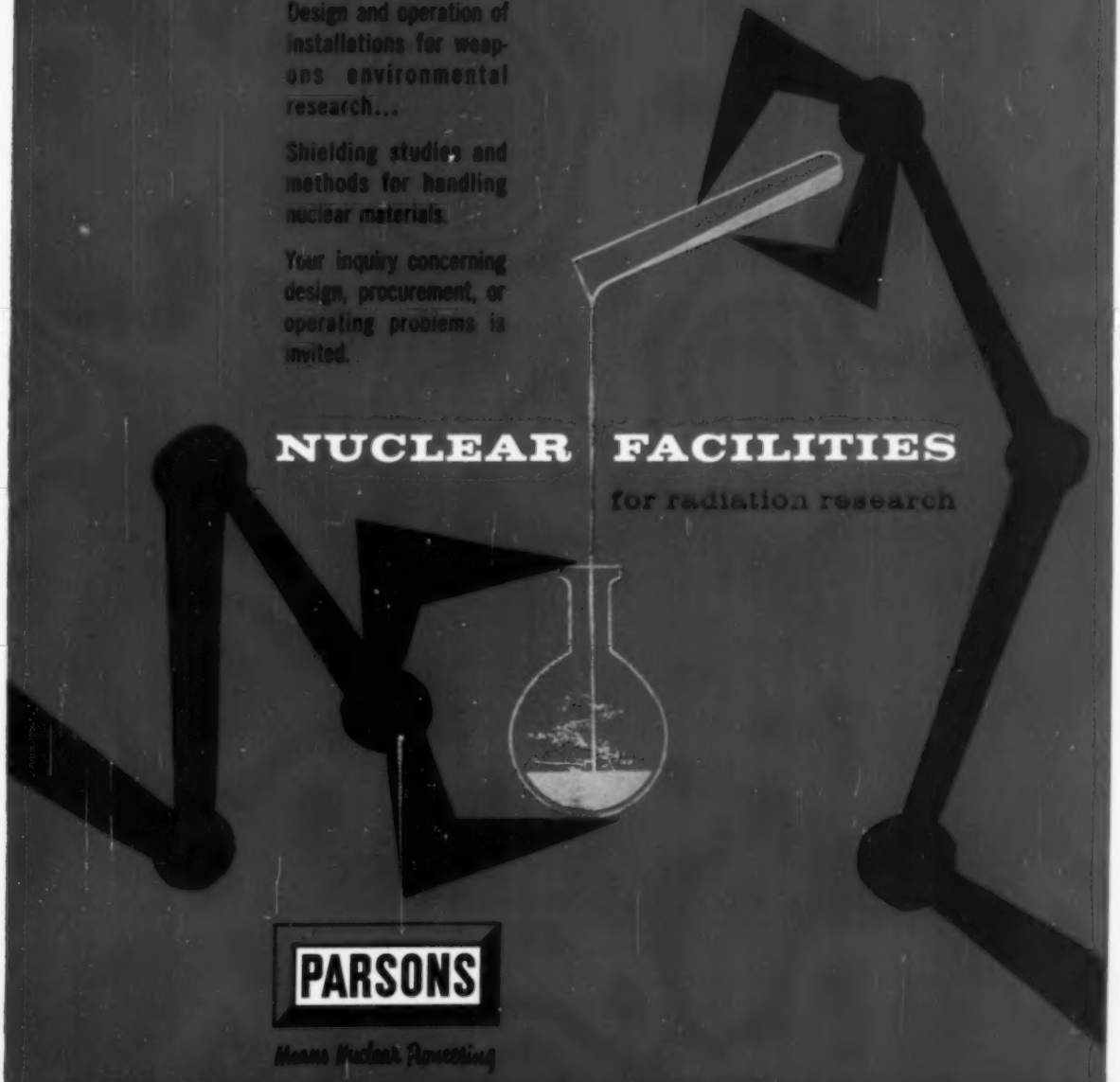

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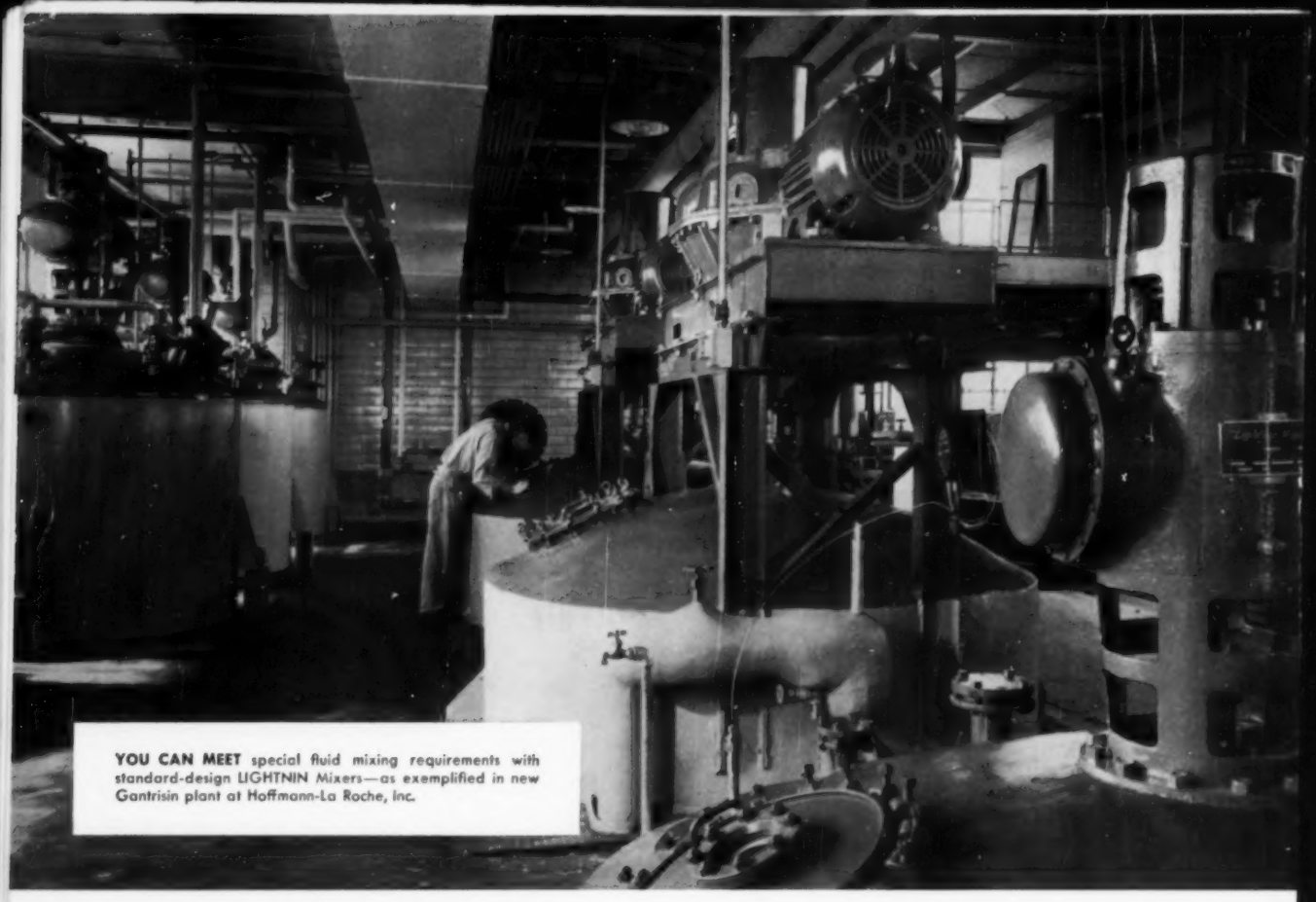

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